CHAPTER 70

LIST OF EFFECTIVE TEMPORARY REVISIONS

FOLLOWING IS A COMPLETE LISTING OF ALL ACTIVE TEMPORARY REVISIONS (TR'S). TR'S NOT LISTED SHOULD BE REMOVED. THE ATA NUMBER, CONFIG CODE AND PAGE NUMBER IDENTIFIES THE PAGE PRECEDING THE TR.

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NONE

CHAPTER 70

ENGINE STANDARD PRACTICES

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CONTAMINATION CAUSED BY LOW MELTING POINT ALLOYS

1. General

Contamination of a material by a low melting point alloy can, at certain temperatures, lead to intercrystalline penetration and subsequent embrittlement and cracking.

2. Contamination by cadmium plated tools

It is possible for deposits of cadmium to be transferred from a tool to the surface of an engine component, in the case of titanium components this could result in rapid failure of the compound under certain running conditions.

The failure is caused by the cadmium reacting at certain temperatures with the titanium, resulting in embrittlement and cracking.

In view of this any tool or item of equipment which is liable to come into contact with titanium must not be cadmium plated.

IDENTIFICATION OF SELF LOCKING NUTS

1. Identification of twelve point self-locking nuts for low and high temperature applications

   A. These two types of self-locking nuts are geometrically similar, but with the following distinguishing features.

      (1) Nuts that must be used in the hotter engine zones, in working temperatures of 230 degrees C. (446 degrees F.) to 650 degrees C. (1,202 degrees F.) are non magnetic, silver plated and partially knurled on the flange; see fig.1.

      (2) Nuts that are restricted to use in the colder engine zones, in working temperatures not exceeding 230 degrees C. (446 degrees F.) are magnetic, cadmium plated and coated with molybdenum disulphide (black). They feature a plain flange. See fig.1.

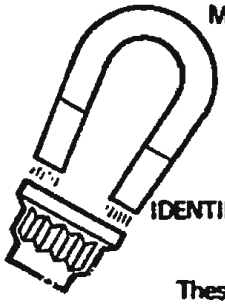
      (3) Positive identification of used nuts into these two broad groups, can only be done individually checking each nut with a magnet.

      (4) Ensure that only the correct nut (as defined in the Illustrated Parts Catalogue) is fitted. It must not be assumed that all low temperature zones of the engine feature magnetic cadmium plated nuts, as quite often high temperature type nuts are by design to be found in these areas.

LOW TEMPERATURE NUTS ARE BLACK AND HIGH TEMPERATURE NUTS ARE BRIGHT WHEN NEW BUT-
DO NOT IDENTIFY BY COLOUR AFTER USE

FITTING OF LOW TEMPERATURE NUTS IN HIGH TEMPERATURE AREAS WILL CAUSE ENGINE FAILURE

LOW TEMPERATURE NUTS UP TO 230°C



MATERIAL:- Medium carbon Ni-Cro-Mo steel

FINISH:- Cadmium plate + black coating of molybdenum disulphide

IDENTIFICATION:- Nut flange has NO knurling

These nuts are MAGNETIC

HIGH TEMPERATURE NUTS UP TO 650° C

MATERIAL:- 15% Cr-25% Ni heat and corrosion resistant steel

FINISH:- Silver plate

IDENTIFICATION:- Nut flange is KNURLED

These nuts are NOT magnetic

These nut become black after use

NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS		NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS		SBAC No.
These nuts have manufacturer's code only on the flange				These nuts have part No. and/or manufacturer's code on the flange	No 8-36	1205943	U125943	AS20623
	No 10-32	1205924	U125924		No 10-32	1205944	U125944	AS20624
	.250-28	1205925	U125925		.250-28	1205945	U125945	AS20625
	.3125-24	1205926	U125926		.3125-24	1205946	U125946	AS20626
	.375-24	1205927	U125927		.375-24	1205947	U125947	AS20627
	.4375-20	1205928	U125928		.4375-20	1205948	U125948	AS20628
Regular nut	.500-20	1205929	U125929	Regular nut	.500-20	1205949	U125949	AS20629
These nuts have part No & manufacturer's code on the flange				These nuts have part No. and/or manufacturer's code on the flange	No 8-36	1209171	U129171	AS27821
	No 10-32	1209162	U129162		No 10-32	1209172	U129172	AS27822
	.250-28	1209163	U129163		.250-28	1209173	U129173	AS27823
	.3125-24	1209164	U129164		.3125-24	1209174	U129174	AS27824
U1259	.375-24	1209165	U129165		.375-24	1209175	U129175	AS27825
Deep counterbored nut				Deep counterbored nut				

31004

Identification of self-locking nuts
Fig.1

TURBINE FUEL HANDLING AND QUALITY CONTROL

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The following fuel handling and quality control procedure has been compiled by Rolls-Royce in conjunction with certain major Fuel Suppliers for the guidance of Operators.

INTRODUCTION

Fuel contamination can broadly be separated into two categories, water and solids, either organic or inorganic.

Water

A maximum free and suspended water content of 30 p.p.m. (excess over saturation) can be tolerated in the uplift of turbine fuels as a realistic figure recognisable by the available fuel test equipment.

Aircraft and engine fuel systems are designed to cater for limited quantities of water in the fuel supply. With fuel heating fitted, the engine will function satisfactorily with a total maximum water content of 0.025% by volume, including the normal amounts of dissolved water up to 0.02%, depending on the temperature of the fuel and the atmospheric conditions.

The engine may not function if slugs of water pass into it, and it is obviously not practical to cater for unlimited quantities of free or suspended water in the fuel. It is therefore necessary to take stringent precautions to ensure that fuel is delivered to the aircraft free from suspended or free water above a concentration of 30 p.p.m.

Solids

It is considered that at present 1 mg./litre dirt content is a workable maximum for fuel as delivered to the aircraft. This is quoted as an absolute maximum on a worldwide basis assuming that on most occasions fuel will be delivered to a much lower dirt content. This maximum limit should include both organic and inorganic matter since both affect the engine fuel system.

1. MOBILE REFUELLING

A. Airfield storage tanks

(1) Storage tanks should be inspected at intervals of not more than 18 months and upon any indications of rust contamination (e.g. by clogging of bulk filters at more frequent intervals than considered normal) the tanks should be drained and scoured in accordance with local practice. Change the filter element as necessary.

(2) It is desirable that airfield storage tanks should be filled through an adequate filter.

(3) After refilling, the fuel should be allowed to settle for as long a period as possible. For tanks without floating suction, after the discharge of fuel into the storage tank, it should be allowed to settle for at least 1 hour per foot of depth of the product in the tank before any withdrawals are made. Where floating suctions are employed, a five-hour minimum settling time should be allowed. After this fuel may be drawn off to a depth of four feet below the initial level of the fuel. The rate of withdrawal of fuel thereafter is controlled by the need to permit the fuel to be settled at a rate of one foot per hour.

(4) Checks for free water must be carried out after the settling period, daily, and after heavy rain. Water detecting paper or paste should be used for these checks. Since these reagents are effective only when brought directly into contact with bulk free water, they should be applied to the end of a rod or dipstick so that sampling is carried out at the bottom of the tank.

Two typical examples of water detecting reagents are:

(a) A water detecting paper which is normally brown, the presence of water being shown by the removal of the colouring, leaving a white surface. Reaction time is about 10 seconds.

(b) A paste which is normally green and which in the presence of water changes to lavender. Reaction time should not exceed 10 seconds.

If water is found it must be drawn off completely from the tank

B. Transfer of fuel from airfield storage tank to refueller

(1) Floating suction is generally employed for the off-take of fuel from storage, although in isolated cases bottom suction may still be encountered. In either case an efficient water separator/filter is strongly recommended between the storage and the refueller. If this is not possible at this point nominal 5 micron filtration must be provided. Differential pressure gauges must be fitted on water separators and/or micro filters and frequent records taken. Drain the water separator sumps daily. Regular checks should also be made to ensure floating suction is operating correctly.

(2) With either method of off-take fuel should not be taken at less than nine inches from the bottom of the tank to ensure that any water or solid contaminant which has settled out will not be transferred to the refueller.

(3) Closed circuit filling should be used, wherever possible, but where this is not provided the filler orifice on the refueller should be shrouded to prevent ingress of water and foreign matter.

(4) Bottom loading should be employed wherever possible, alternatively the filler pipe from the storage should discharge at the bottom of the refueller tank.

C. Aircraft refueller

(1) The refueller should be allowed, where practicable, to stand for at least 10 minutes after being refuelled to allow contaminants to settle out.

(2) A sample of at least one gallon of fuel should be drained from the refueller at full flush into a clean and dry clear glass container and then a contamination check carried out. The sample should be taken from the sump of the refueller, where fitted. In the case of compartmented refuellers, the sample should be taken from the drain point in each compartment.

Solids. If contamination is visible in the glass container, sampling must be repeated until the acceptable standard is acheived.

Free water. Should be detected by the use of water detecting media, such as paste, paper or suitable types of chemical detector.

Suspended water may be indicated by a cloudy appearance of the sample. It is of assistance to have available a sealed vessel of the same type as is being used for sampling, and containing clean, bright, fuel for purposes of comparison. The sample should always be viewed under standard conditions, preferably against a black background, and at night, with a torch held so as to shine through the sample at right angles to the line of sight. Chemical detectors are available and will give more positive indication of suspended water. These should be used in addition to visual detection. Recommended types of chemical detector are described later in this section.

(3) In the event of free water being found, the refueller should be driven in order to agitate the fuel and then allowed to stand for a period of 10 minutes when another water check should be made, and the procedure repeated until the fuel sample is free of water.

(4) In the event of suspended water being found, the fuel load must be rejected.

(5) Following either (3) or (4) above the source of the contamination must be investigated.

D. Transfer of fuel from refueller to aircraft

(1) Should an Operator wish for an independent check for water contamination, it is recommended that this be carried out before refuelling commences. Refuelling should only commence after fuel has been shown to be free from water.

(2) A 5 micron (nominal) filter or filter/separator should be fitted to the delivery side of the refueller.

(3) Dust covers on refuelling nozzles or connections should not be removed until immediately prior to the transfer of fuel and replaced as soon as transfer is completed. Dust covers, shrouds and nozzles must not be allowed to trail on the ground.

(4) When overwing refuelling is carried out the aircraft filler orifice should be shrouded to prevent ingress of water or foreign matter.

(5) The most desirable check point for dirt contamination of fuel is where the fuel is delivered to the aircraft. If an Operator wishes to make a full flush check it should be done at this location.

E. General

(1) All equipment should be kept scrupulously clean.

(2) Whenever new equipment (e.g. storage tanks or refuellers) is brought into use, major repairs carried out, or the grade of fuel in use is changed (e.g. kerosine or wide-cut) particular care should be taken in handling the fuel and making the quality checks. Since under these conditions there is a greater tendency for any rust that is present to be dislodged, micronic filter differential pressures should be carefully watched, and the filter back flushed or the element changed, according to type, as soon as the recommended safe maximum pressure differential is reached.

(3) It is important that relaxation of precautions should not be allowed to occur at any time because, for example, over a period of several months no evidence of contamination has been found. It is equally important that there should be no seasonal changes in the procedure, as, although aircraft fuel system icing due to water contamination is more often met within winter, contamination of any sort can be equally dangerous during the summer months, and it should be remembered that, on many aircraft, fuel cooling in flight will give fuel temperatures well below zero throughout the year.

2. HYDRANT SYSTEMS

A. Airfield Hydrant Depot

The same precautions apply here as described for airfield storage tanks under 1.A. It should be noted however that hydrant systems are even more critical than other types in view of the difficulties involved in contamination removal.

B. Hydrant Pipe Line

(1) Floating suction should be used for the off-take of fuel from storage with an efficient water separator between the storage and the pipe line. Differential pressure gauges or water separator equipment should be checked frequently and water sumps drained daily. Floating suction must be checked at regular intervals.

(2) Fuel should not be taken at less than nine inches from the bottom of the tank, to ensure that any water or solid contaminant which has settled out will not be transferred to the pipe line.

(3) The pipe line should be graded down to a sump or sumps.

(4) A daily contamination check should be made from the pipe line sump or sumps. At least one gallon of fuel should be drained off at the maximum rate possible, into a clean and dry clear glass container, ensuring that the sample is representative of the contents of the sump. The sample should then be tested for water and solids as previously described.

(5) In the event of contamination being found, the source of contamination should be established and cleared before the hydrant is returned to service.

C. Dispensing Unit

(1) A daily check should be made from the draining points on the dispenser, as previously described for refuellers (1.C.(2)).

(2) If any serious contamination is found, use of the hydrant should be discontinued and the dispenser withdrawn from service until the source is discovered and eliminated.

(3) In view of the fact that there is no intermediate settling period between storage and aircraft, as in the case of mobile refuellers, particular care must be excercised in the checking of hydrant systems.

(4) It is essential to make further checks from the dispenser during or immediately after each refuelling operation.

D. Transfer of fuel from dispenser to aircraft

The same recommendations as for mobile refuellers (1.D.) apply.

E. General

(1) All equipment should be kept scrupulously clean.

(2) Whenever new installations are brought into use, major repairs carried out, or the grade of fuel changed in a hydrant system, fuel should be circulated through the system, with suitable filters in circuit, to flush out and drain the system of solid contaminants or water. This re-circulating should continue until the product is clear. In addition during the early lift of the system, particular attention should be paid to the behaviour of micronic filters and the filter elements should be changed as necessary.

(3) The recommendation of 1.E.(3) regarding relaxation of precautions is particularly emphasized in regard to hydrant installations because of the lack of an intermediate settling period between storage and aircraft.

3. REFUELLING FROM DRUMS

A. General

(1) Refuelling aircraft from drums, barrels, cans or other containers is not a recommended procedure. At certain outlaying airfields, however, it is occasionally necessary to refuel directly from this type of container.

(2) Drum stored fuel should always be treated as suspect, hence extraordinary precautions are necessary to elminate water and solid contamination of the fuel.

B. Drum Construction and Material

Drums used for storing aviation turbine fuel should be constructed of plain drum steel, prefereably lined with an approved lacquer which is unaffected by fuel or water contamination, though when this is done care must be taken to ensure that the lacquer does not flake off if a drum should become dented. Galvanized interiors should never be used, although the exterior may be galvanized to prevent rust.

C. Storage

(1) Drums should be stored preferably under cover, off the ground and on their sides with all bungs beneath the product level and in such a manner that they are visible and accessible, to prevent rain water from entering through faulty bungs.

(2) Each grade and batch of fuel should be segregated and be prominently labelled, and should be used on a 'first in - first out' basis.

(3) A daily check for leaks should be carried out, and leaking drums should preferably be returned to the Fuel Supplier for passing through his quality control procedures. Where this is impossible, the checks described in para. 3.D. should be carried out and the contents, if satisfactory, decanted into sound drums.

(4) The drum markings should be inspected frequently for legibility.

(5) Samples for laboratory analysis should be drawn not later than 12 months from the filling date and subsequently at intervals of not more than 6 months.

D. Pre-fuelling operations

(1) Prior to refuelling, all the drums required for a particular operation should be rolled out and placed in position, close to the parked aircraft or where it will be parked, bungs uppermost.

(2) Sparks may be caused when drums are moved, hence, because of the possible presence of inflammable or explosive fuel vapour, unnecessary movement of drums during refuelling should not be permitted. If movement is essential this should be carried out with care.

(3) The fuel should then be allowed to settle for as long as possible, and in any case not less than 10 minutes, before checking commences.

(4) As the bung is removed from each drum a free water check should be made by means of water detecting paste or paper on the end of a rod to sample the liquid at the bottom of the barrel (see para. 1.A.(3)). If possible, a sample should be drawn off by 'thief' pump or plastic tube and submitted to a visual check for colour and solid contaminants and visual and chemical check for suspended water (see para. 1.C.(2)).

(5) If free water or solid contaminant is found, it should be drawn off and the contents of the drum decanted into a clean and dry container, which should then be allowed to settle. Before use carry out check (4) again.

(6) If suspended water is found, the drum should be rejected, removed to a location where it is unlikely to be used by mistake, and the grade markings cancelled, the batch code being retained. The source of contamination should be investigated in order to prevent possible recurrence.

(7) After the contaminant checks have been carried out, the bungs should be replaced until a drum is actually required for refuelling.

(8) Note that it is extremely important to check each drum, as there is no guarantee that any particular batch of drums is free from contaminants.

E. Refuelling

(1) The fuel should be withdrawn from the drums by means of a drum standpipe made of brass, or steel sheathed with copper or brass. The pipe should have the bottom end cut off at an angle such that the bottom 3 in. of the drum contents will not be withdrawn, and should fit the bunghold, or be provided with a shroud to cover the bunghole.

(2) The standpipe should be connected to a suitable hand or power-operated pump, which should then deliver through a 5-micron (nominal) filter and thence to the delivery nozzle which should shroud the filler neck. The pump should be situated close to the drums and not on the aircraft wing.

(3) If a micronic filter is not available, some protection is afforded by delivering to the aircraft filler via a chamois leather or nylon cloth filter, which should shroud the filler neck. This should, however, only be considered as a last resort.

F. Bonding

Before refuelling commences it is essential that electrical continuity throughout the system from drum to aircraft is ensured. This is normally obtainable as follows:

(1) Provision of a bonding clip connection between standpipe and barrel.

(2) Electrical continuity through hoses and pumping equipment.

(3) Provision of a bonding cable on the pumping equipment, the cable to be connected to the aircraft structure before taking out the delivery hose.

(4) Filling nozzles and funnels, if used, to be provided with bonding clips to ensure continuity from nozzle through to aircraft structure.

G. Re-use of drums

It is strongly recommended that drums should not be re-used for aviation fuel unless re-submitted to the Fuel Suppliers' cleaning procedures. If, however, circumstances demand that they must, the following precautions should be observed.

(1) Before re-filling, the drums should be cleaned and carefully examined internally for good condition and freedom from contamination.

(2) New bung washers should be used after re-filling.

(3) Previous markings on the drum, if different from the product in hand, should be destroyed, and new markings stencilled on.

(4) Under no circumstances should a drum previously used for any other products be re-used for aviation fuel.

4. AIRCRAFT REFUELLING CHECKS

A. Before and after refuelling has been completed it is recommended that a water drain check should be made at the aircraft, checking samples from all relevant drain points. This is particularly important where aircraft turnrounds are of short duration and settling time after refuelling may consequently be inadequate. Where possible at least 20 minutes should elapse before sampling.

B. Free water should be detected by means of paper or paste or suitable types of chemical detector and suspended water by visual and chemical means (see para. 1.C.(2)).

C. If free water is found, continue to draw off samples until the fuel is free from water.

D. If suspended water is found, the cause must be established. Cloudiness of the fuel samples caused by precipitation from solution when the warm fuel meets the cold fuel may be disregarded provided that it has been established that the previous and the present uplift are free of water.

5. THE ENGINE L.P. FILTER

Because of the very high filtration rating of the engine L.P. filter it is not designed to hold large amounts of cumulative dirt but is only intended to cope with small amounts of dirt normally encountered in the average aircraft system or a sudden emergency of short duration. In addition it is intended to give a final polish up to already clean, dry fuel. It does, however, provide the last line of defence in combating contamination and provides a valuable guide to the Operator in the assessment of fuel quality. From the point of view of the engine it is considered that the L.P. filter is one of the best known indicators of fuel contamination or of breakdown in the airport supply system and for this reason, where contamination is thought to exist. Laboratory examination of engine filter elements will often give a useful lead to the source of breakdown. It must be accepted that the lower the fuel standard the more frequent must be the engine L.P. fuel filter changes.

6. CORROSIVE SULPHUR

It is known that corrosive sulphur in aviation fuel can cause serious damage to aircraft and turbine engine fuel system components, particularly fuel pumps. In general this formation is associated with unsatisfactory storage conditions, inadequate fuel handling and quality control and climatic environment, the danger being greatest in warmer climates. The following notes are given as a guide to identification of corrosive sulphur in fuel, the cause of formation and means of testing.

General

Corrosive sulphur can form in aviation fuel stored in contact with water in which active sulphate reducing bacteria is present. This is most likely to occur in storage tanks or bulk containers which have deteriorated due to inadequate cleaning and maintenance.

The bacteria causing the formation of corrosive sulphur in stored fuel thrive in stagnant, unaerated water, particularly if the water contains sludge and decaying organic matter. These bacteria, in their life cycle, give rise to sulphides, such as sulphuretted hydrogen, the greatest reaction being when the water temperature is higher than 25 deg.C and in contact with iron. Activity is equally virulent in salt or fresh water and can persist in sludge.

Dangerous pollution can occur in a relatively small quantity of water or sludge the degree being directly related to the cleanliness of the storage tank. The greatest rate of fuel contamination occurs with only a small quantity of fuel in the tank and this condition should be regarded as the most dangerous.

If for any reason the presence of corrosive sulphur in fuel installations is suspect, the following tests should be applied.

A. Method of checking for sulphides

The method of testing a tank for the presence of sulphides is to take a sample of the water and sludge from the bottom of the tank, acidify the water and check for the evolution of hydrogen sulphide by the use of lead acetate paper.

The sample should be taken in a clean, sterile, dark glass bottle; a metal container must not be used. In all probability the sample will consist of water and fuel, therefore, before carrying out the test for sulphides, the fuel must be removed from the sample.

The test should be carried out with as little delay as possible after taking the sample, to the following method:

(1) Shake the sample so that any sediment will be suspended in the water. This is essential as the sediment may consist of iron sulphide produced by sulphate-reducing bacteria.

(2) Transfer 100 ml. of the water/sediment suspension to a conical flask of 200 ml. capacity.

(3) Add to the flask 20 ml. of a 10% solution of dilute sulphuric acid and immediately place in the neck of the flask a lead acetate paper folded to the shape of a 'Vee'.

(4) Bring the water to the boil, and continue to boil it gently for three to four minutes.

If the lead acetate paper turns black or brown, sulphides are present in the sample.

B. Method of testing fuel in bulk storage

The fuel should be subjected to a copper strip corrosion test for 2 hours at 100 deg.C in accordance with the latest issue of the American Society for Testing Materials (A.S.T.M.) Method D.130, Paragraph 7(b), or Institute of Petroleum (I.P.) Method 154, Procedure 'C'. The current editions of these documents are D.130-56, and 154/58 respectively.

Attention should be paid to the following points:

(1) The fuel sample should be drawn from the lower half of the tank in a clean, dark, glass bottle, and every precaution taken to shield it from strong natural light. Do not use a metal container for this purpose. No undue delay should occur between taking the sample and making the test.

(2) If the copper strip test result in worse than Classification No.1 of either the A.S.T.M. Method or the I.P. Method, the fuel should be rejected as unfit for use and removed from the tank. When the fuel has been removed, the tank freed of gas, and the usual safety precautions taken, the tank should be cleaned by scraping, wire brushing, and if practical, shot blasting all interior surfaces to remove all loose rust and deposits.

Even if the corrosion test indicates that the fuel is fit for its intended use, the tank must still be tested for free water and sludge. Any water and sludge found should be removed, and tested immediately for sulphides as described. If sulphides are found, the fuel should be removed immediately and stored in a clean tank, and the polluted tank should be cleaned, as soon as possible, as outlined in paragraph 6.B.(2). If no sulphides are found, all free water and sludge should be removed from the tank, even though in the first instance to do this may necessitate cleaning the tank.

Once a tank has been tested and found to be satisfactory for the storage of fuel, or cleaned to make it so, it is essential to ensure that neither dirt nor water subsequently enter the fuel. Under airfield conditions it is difficult to prevent a small quantity of water getting into bulk storage tanks, but this quantity can, and must, be kept to a minimum by adequate safeguards as already detailed. Where the presence of corrosive sulphur has been confirmed or is suspect it is essential that in addition to the normal Quality Control Standard fuel in storage must be checked, at monthly intervals, as described in para. 6.B.(2).

7. ACTION TO BE TAKEN IF AIRCRAFT CONTAMINATION OR FUEL IRREGULARITIES ARE SUSPECT

Much evidence in the past has been lost or destroyed by incorrect procedures in sampling and recording incidents of contamination.

The following notes are given for the guidance of those immediately concerned in such incidents.

A. Samples must be taken at all aircraft and engine drain points. These must be collected directly into clean glass containers of not less than 1 quart size. These containers must immediately be effectively sealed and retained.

B. Where contamination is confirmed, repeat sampling must be made until either the contamination is cleared or confirmed as being extensive.

C. When engine L.P. filters are removed care should be taken to collect all fuel from the filter housing into a clean glass container which should at once be sealed.

D. L.P. filter elements must immediately on removal be placed in a polythene bag and sealed to retain all moisture. On no account must these elements be handled or left to dry.

E. In the event of water being found in L.P. filter housings it is most important that the source of this is defined and checks made on all fuel tank drains.

F. A careful record should be made of each action taken and its results, this should also include details of fuel supply, method used, i.e. truck or hydrant at last uplift and the fullest possible details on any items which might indicate irregularity.

G. All samples must, on removal, be clearly and indelibly labelled with full details, date, engine number, position, hours operated, location of incident and any other data which may be relevant.

8. WATER DETECTORS FOR TESTING AVIATION TURBINE FUELS

The detection of undissolved water in fuel in the form of a suspension of very fine droplets or 'haze' can under some circumstances be very difficult by visual inspection, and certain fuel companies have developed chemical detectors to give more positive indication of suspended water.

Either of the following two such devices is recommended for use in addition to visual inspection.

A. A 'Detector Unit' developed by the Shell Thornton Research Centre consists of a small element of filter paper, sensitized with chemicals and mounted in a plastic head. This is made to fit the 'Record' taper of a standard 5 ml. hypodermic syringe.

If suspended water is present in the fuel sample, the exposed centre portion of the filter paper undergoes a chemical reaction, causing a distinctive colour change in contrast to the outer rim of the paper. This change varies with the ratio of suspended water present in the sample, detector indication ranging from 0.003% wt. to 0.01% wt. at which stage the dye-content is fully saturated.

The Unit and instruction can be obtained from:

Shell Aviation Department,
St. Helen's Court,
Gt. St. Helen's Street,
LONDON, E.C.3.

Nylon unbreakable hypodermic syringes 5 ml. size suitable for use with the Shell detector are obtainable from:

Charles F. Thackray Limited,
Park Street,
LEEDS.

B. A 'Hydrokit' developed by the Esso Research and Engineering Company is a simple 'go-no go' test. It employs an extremely sensitive colour indicator calibrated for 30 p.p.m. of water. If the indicator changes colour the sample FAILS: water concentration is 30 p.p.m. or above. If it doesn't change colour the sample PASSES: water concentration is below 30 p.p.m.

The Hydrokit package consists of 25 standard jars, 25 capsules of indicator, and a set of instructions. The indicator capsules are contained in one of the jars, which also contains a desiccant to keep the capsules dry. Such a package contains everything necessary for 25 fuel samplings.

For locations where frequent testing is anticipated, a second Hydrokit package is available. It contains 25 jars, with each jar containing 25 capsules - enough for 625 samplings.

The jars may be used over and over again if due care is observed in cleaning and drying them.

The Hydrokit and instruction can be obtained from any Esso Aviation petroleum service.

9. GLOSSARY

Dissolved water is that which is soluble in fuel and which is only detectable by laboratory tests.

Suspended water is water in extremely fine droplet from which remains suspended in the fuel for periods in excess of 10 minutes.

Free water is water in such a form that it readily separates.

MODULE IDENTIFICATION AND INTERCHANGEABILITY

1. General

The RB.211 engine is of modular design and consists of seven main assemblies (modules) each one having its own mark number identification.

2. Module Mark Number

R The module mark number can consist of either five digits with a
R letter M prefix or five digits with a letter M prefix and a two
R letter suffix, i.e. M01205 or M01560AA; M indicates Module.

The first two digits, i.e. 01, indicate the basic identification number for each module as follows:

01 Low Pressure (L.P.) Compressor (Fan) Module
02 Intermediate Pressure (I.P.) Compressor Module
03 Intermediate Module
04 High - Pressure (H.P.) System Module
05 L.P. and I.P. Turbine Module
06 External Gearbox Module
07 L.P. Compressor Case Module

R The remaining three digits and two letter suffix i.e. 560AA
R indicate the Service Bulletin (SB) standard of the module and
R will only be altered e.g. 560AA to 561AA when a S.B. is introduced
R affecting interchangeability (physical and functional) with
R another module.

R Module mark numbers prior to 500AA will be changed whether
R interchangeability is effected or not, i.e. 205 to 206.

R Module mark numbers may not necessarily change in numeric
R sequence, i.e. 560AA to 561AA, but may change to the next
R sequential number available, i.e.560AA to 571AA.

R To reduce the allocation of new module mark numbers, the two
R letter suffix only is changed when a SB is introduced which
R affects interchangeability between a module and non modular
R parts e.g. 562AA to 562AB.

3. Module Identification

Identification of the Module is by means of an identification plate, showing the Module Mark number, e.g. 01205 or 01560AA.

With the exception of Module 01, L.P. Compressor (Fan), each identification plate is secured to its appropriate Module as follows:-

Module 02 - I.P. Compressor. Plate located on stage 5 stator front flange.
Module 03 - Intermediate. Plate located on H.S. external gearbox bevel drive gear housing flange.
Module 04 - H.P. system. Plate located on fuel spray nozzle housing flange.
Module 05 - L.P. and I.P. turbine. Plate located on front flange of L.P. turbine bearing support.
Module 06 - External Gearbox. Plate located on oil tank cover flange.
Module 07 - L.P. Compressor Case. Plate located on right-hand side of case.

The identification plate for Module 01 is fitted to the L.P. Compressor fan case whenever the module is installed. During storage and transportation of the module the plate is loosely attached to the module.

A Modification/Service Bulletin certificate is prepared for each module and is to be retained with other associated documentation for the propulsion unit. The certificate records the Module Mark Number in addition to details of the build standard.

On replacement of a module, the modification certificates are exchanged and that for the replaced module is amended as necessary to indicate additional modification/service bulletins which are incorporated in the module during overhaul/repair.

4. Module Interchangeability

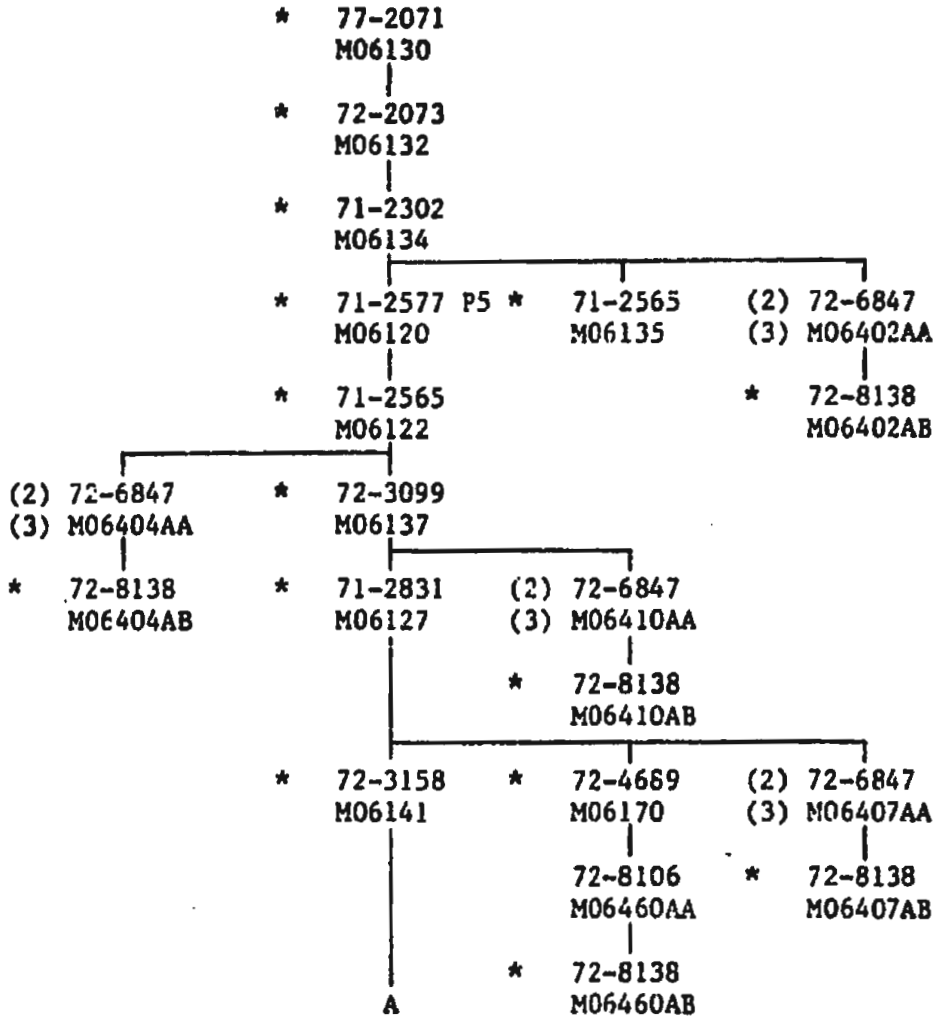
R Module interchangeability is illustrated on two different types
R of chart, the module mark number chart and the module
R interchangeability chart.

R A. Module Mark Number Chart

R The module mark number chart illustrates the progression from
R the DIS standard module to the latest standard and details
R the Service Bulletin to Mark Number relationship. If
R non-modular parts are affected when a new module mark number
R introduced, an asterisk is inserted next to the Service
R Bulletin number. If another module is affected by the same
R Service Bulletin the appropriate module number in brackets
R is inserted next to the module mark number e.g. (2) indicates
R module 02 is also affected. Each mark number chart
R is specific to one module and all mark number charts are
R included as figure 1.

R B. Module Interchangeability Chart

R Module interchangeability charts comprise a matrix of 0 and
R + with a module mark number to the left-hand and a
R corresponding mark number across the top. The
R interchangeability of two modules is denoted by the symbol
R at the intersecting point, reading down from the module number
R on the top and across from the module number on the left.
R The symbol 0 denotes not interchangeable and + denotes
R interchangeable. Each interchangeability chart is
R appropriate to two connecting modules and it is necessary to
R read all charts associated with a module in order to
R establish that particular modules interchangeability. The
R appropriate chart should be selected from the following:



* = Non-modular parts affected
( ) = Other module affected
NOTE: The changes affecting module 06 are introduced by SB 72-4557 or SB 72-7166 and these SB's are specified within SB 72-6847 as essential

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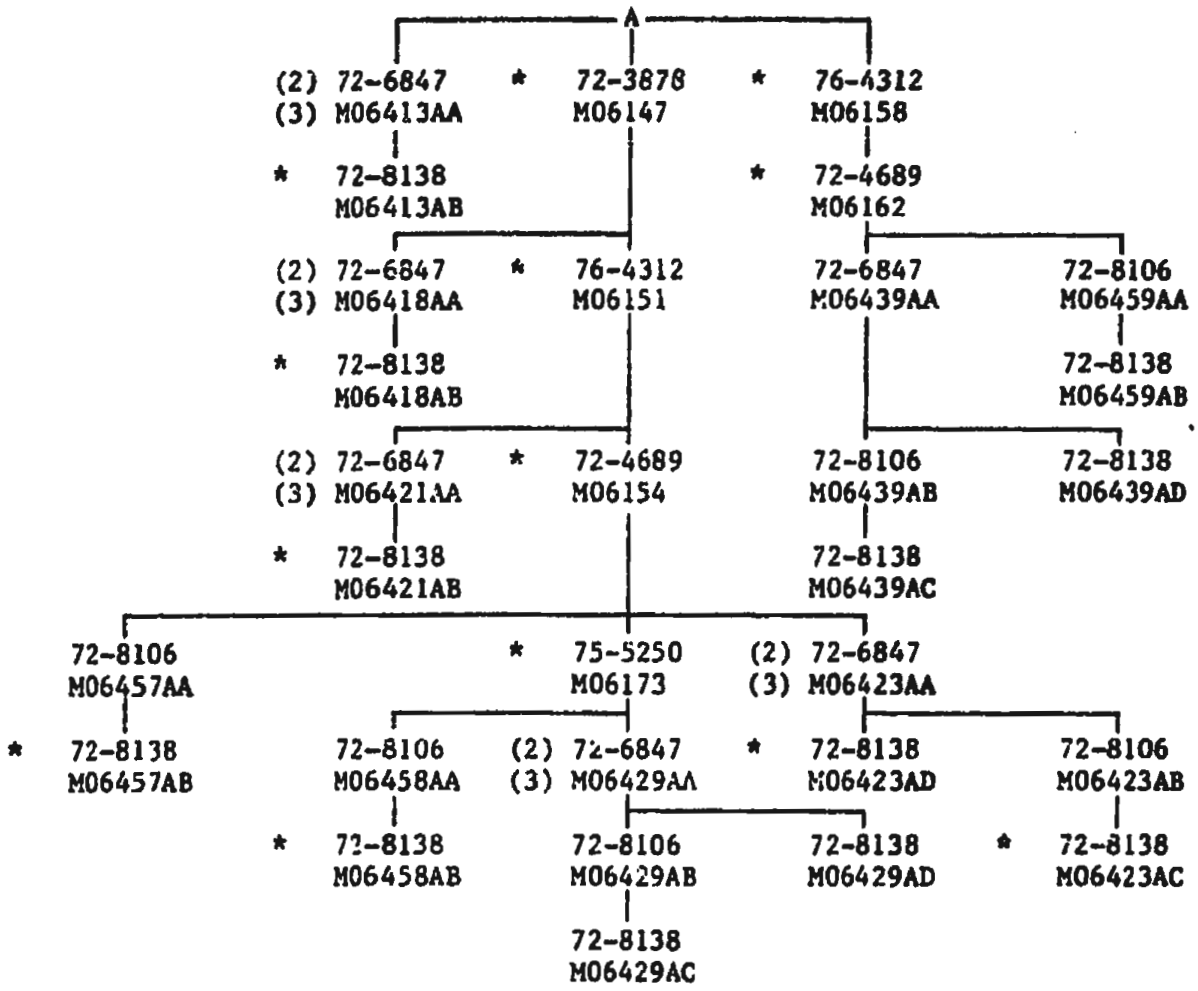
R RB.211-22B-02/10
R Module 06 and mark number chart
R Fig.1, Sheet 1 of 3



* = Non-modular parts affected
( ) = Other module affected
NOTE: The changes affecting module 06 are introduced by SB 72-4557 or SB 72-7166 and these SB's are specified within SB 72-6847 as essential

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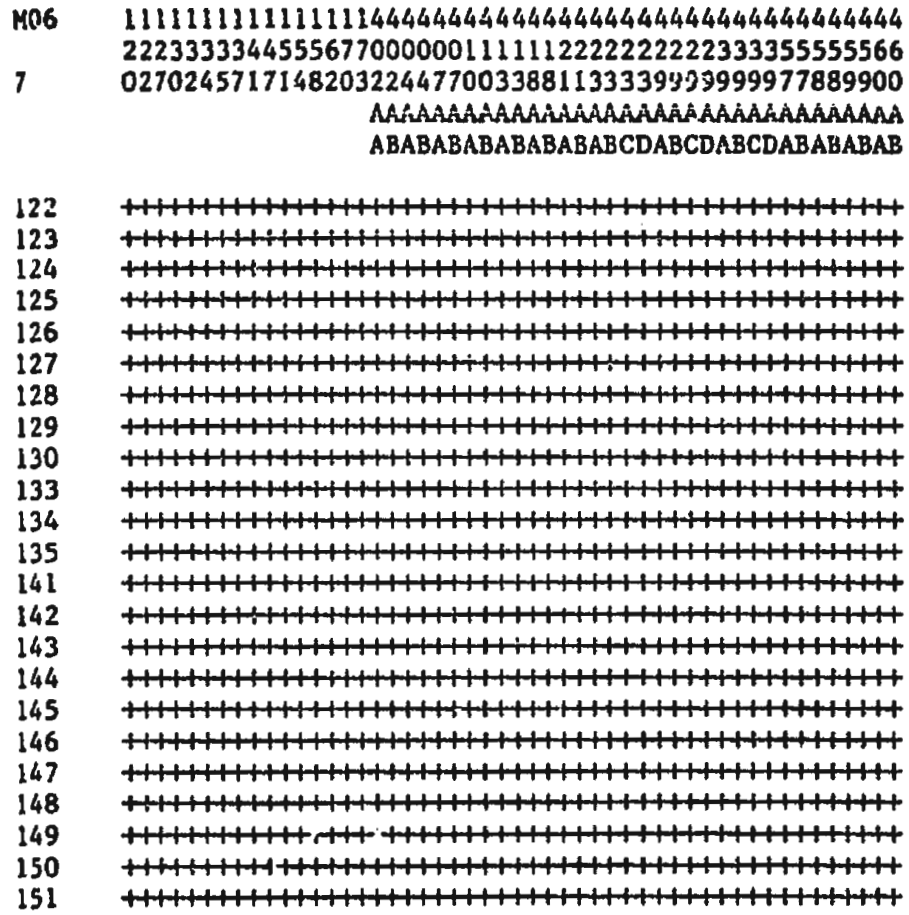
RB.211-22B-02/10
Module 06 mark number chart
Fig.1, Sheet 2 of 3

EFFECTIVITY: ALL



+ = INTERCHANGEABLE 0 = NON-INTERCHANGEABLE 84089A

R RB.211-22B-02/10
R Interchangeability - Module 06/Module 07
R Fig.1, Sheet 3 of 3

R EFFECTIVITY: ALL
R

FLIGHT PROFILES AND OPERATIONAL MONITORING - GROUP 'A' PARTS

1. General

The failure of a major rotating part can have very serious consequences. Such critical parts are collectively termed Group A Parts; a mandatory - not to exceed - life limit is declared for each of them. These lives are specified in the
R Time Limits Manual, Chapter 5-10-01.

A. Datum Flight Profile

Cyclic life limits are determined by Rolls-Royce in terms of engine cycles from O-max-O rpm. These limits are then converted into equivalent flight cycles based on the rate of fatigue life usage determined from the datum flight
R profile, see fig.1 or fig.2 as applicable.

R B. Actual Flight Profile

R As the life limit for Group A parts is determined by reference
R to the datum flight profile, it is most important for
R Operators to establish their individual flight profile in case
R variations from the datum make it necessary to review the
R declared life limits. It is the responsibility of Operators
R to define the flight profile which is representative of their
R entire route structure and provide Rolls-Royce with the
R results in the format of the datum flight profile. Such a
R profile will also show the frequency and amplitude of rpm
R excursions from top of descent to application of reverse
R thrust. The ambient temperature or Total Air Temperature
R (TAT) at take-off must also be shown.

R Rolls-Royce should be provided with this profile as soon as
R possible after the date of commencement of operations, and in
R any case not later than three months from that date.

R C. Monitoring of the Actual Flight Profile

R Periodically at intervals not exceeding one year from the
R date of the first return as in paragraph B, Operators should
R repeat the check and provide Rolls-Royce with an updated
R flight profile. Additionally, the check should be repeated
R if, at any time, the Operator has reason to believe the
R flight profile as submitted to Rolls-Royce is no longer
R representative of this operation.

D. Definition of a Flight Cycle

Normal flying

A normal take-off to landing according to the Datum Flight Speed Profile for the engine type, See fig.1 or fig.2 as applicable.

Pilot Training

One 'flight cycle' for the initial take-off and final landing. The following additions must also be made for each 'touch and go' or 'overshoot' recorded on the aircraft for the period during which the engine was installed.

R (1) One 'flight cycle' for the following shafts:

R (a) LP compressor shaft

R (b) LP turbine shaft

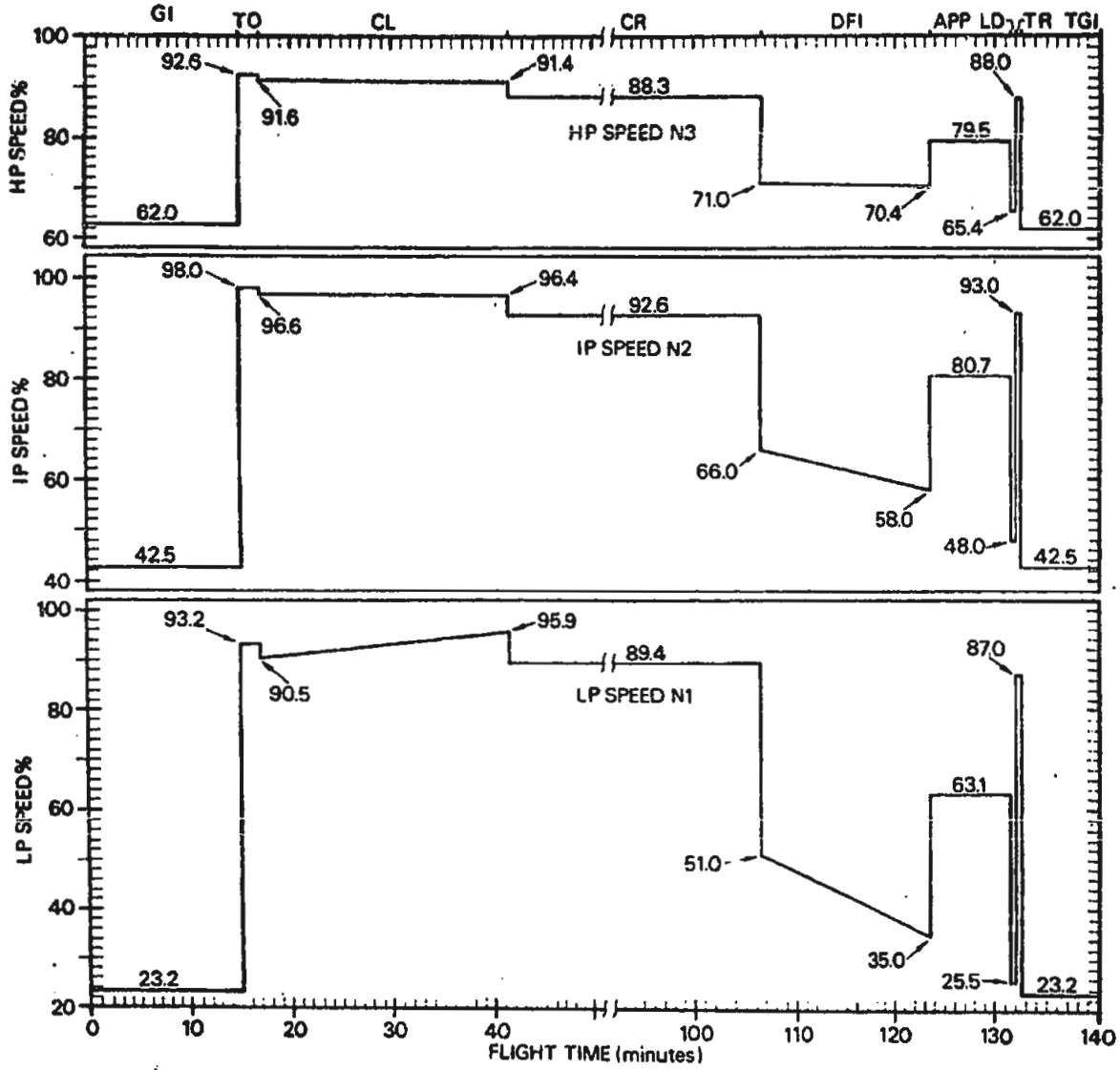
R (c) IP compressor rotor rear stubshaft

R (d) IP turbine shaft

R (2) One fifth of a 'flight cycle' for all remaining Group 'A'
R Parts.

Example

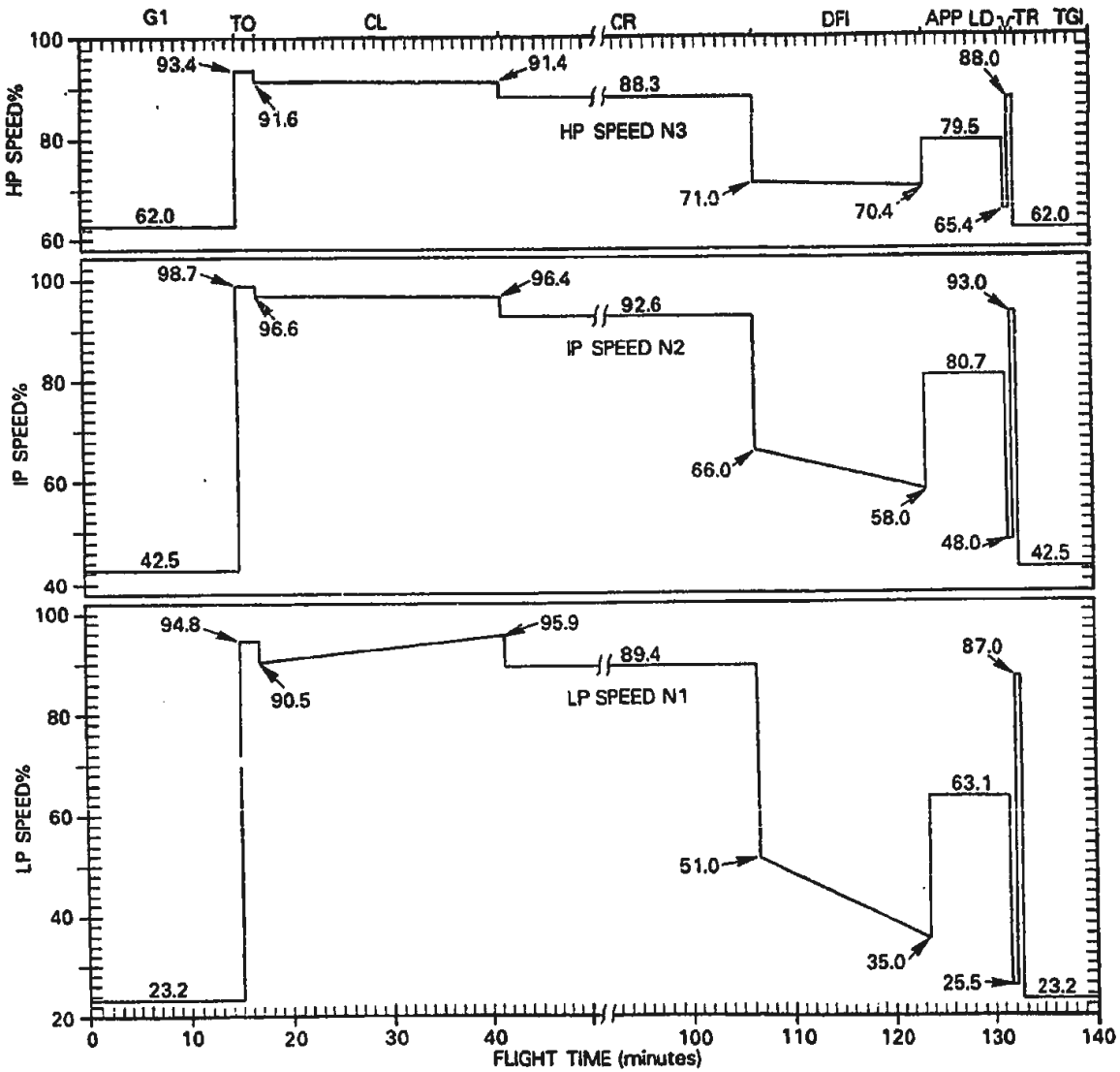
One training flight that includes one 'overshoot' and four
R 'touch and go' is the equivalent of six flight cycles for
R shafts as specified in (1) above and two 'flight cycles' for
R all other Group 'A' parts.



GI GROUND IDLE
TO TAKE-OFF
CL CLIMB
CR CRUISE
DFI DESCENT FLIGHT IDLE
APP APPROACH (3½ Hold cycles)
LD LANDING IDLE
TR THRUST REVERSE (10 secs)
TGI TAXI GROUND IDLE

34959A

RB211 - Datum Flight Speed Profiles
(RB211-22B Engines without S.B.72-8700)
Fig.1



22B Engine with
SB 72-8700

GI GROUND IDLE
TO TAKE OFF
CL CLIMB
CR CRUISE
DFI DESCENT FLIGHT IDLE
APP APPROACH(3½ Hold cycles)
LD LANDING IDLE
TR THRUST REVERSE(10secs)
TGI TAXI GROUND IDLE

A8511

RB211 - Datum Flight Speed Profiles
(RB211-22B Engines with S.B.72-8700)
Fig.2

IDENTIFICATION, LUBRICATION AND FITTING OF RUBBER SEALING RINGS

1. Identification

A. Rubber sealing rings are identified by the part number on the envelope in which the rings are individually packed. Each envelope is marked with the following minimum information.

(1) Description of part

(2) Quantity

(3) Engine manufacturers part number

(4) Cure date

B. The storage life of a sealing ring is calculated from the cure date stamped on the envelope. A table of storage periods is given in 70-61-01. For the purpose of cure date marking, a year is divided into quarters as follows:

1st quarter - January, February and March
2nd quarter - April, May and June
3rd quarter - July, August and September
4th quarter - October, November and December

The quarter number and the year, separated by the letter Q indicates the cure date. A cure date of 2Q71 indicates the cure date being in the second quarter (April, May or June) of 1971. The storage life may be calculated from this date.

C. The sealing ring material is identified by the colour of the ring material or by the colour coding marks on the outside diameter of the ring. A table of colour codes in relation to material codes and materials is given in Fig.1.

Base colour	Number and colour of spots or lines	Material code	Material
black	1 yellow	F/E or WAD	Neoprene
black	1 yellow, 1 white	PE/FK or WAJ	Nitrile
black	1 yellow, 1 blue, 1 green	R/G or WAG	Natural rubber
black	2 yellow	E/ORK	Nitrile
black	2 yellow, 1 blue	PE/EK or WAN	Nitrile
black	2 yellow, 2 green	VE/S or WAT	Fluorocarbon
black	3 yellow	PE/OZR or WAK	Nitrile
black	4 yellow	VE/KR or WAS	Fluorocarbon
black	part number in white ink	PE/DCR or WAL	Nitrile
black	1 white, 1 blue	PE/ELR	Nitrile
black	1 white, 2 blue	B/SK or WAB	Silicone
black	1 white, 2 green	E/PVC or WAQ	Nitrile/PVC
black	1 white, 1 blue, 1 yellow	E/XCF or WAP	Nitrile/PVC
black	1 blue, 1 green	E/ORP	Nitrile
black	1 blue, 1 white, 1 green	PE/ERS	Nitrile
black	1 blue, 1 green, 1 yellow	N/GP or WAC	Neoprene
black	2 blue	E/ORS	Nitrile
black	3 blue	N/Q	Neoprene/Nitrile
black	1 green, 1 white	PE/FR	Nitrile
black	1 green, 1 yellow	E/OR	Nitrile
black	1 green, 2 yellow	E/ORK or WAN	Nitrile
black	3 green	PE/RN	Nitrile
black	4 green	VE/HT or WAR	Fluorocarbon
brick red	2 black graphite	SE/DT	Silicone
red	1 green	GF/ST	Silicone
red	None, self-coloured	E/ET	Silicone
orange	None, self-coloured	SE/MP or WAH	Silicone
green	None, self-coloured	SE/F	Silicone/P.T.F.E.
blue	None, self-coloured	SE/G	Silicone
pale blue	None, self-coloured	SE/CH or WAU	Silicone
grey	None, self-coloured	SE/FM	Silicone/P.T.F.E.
brown	None, self-coloured	SE/MH	Silicone
brownish red	None, self-coloured	SE/DTA	Silicone
light brown	None, self-coloured	WAF	Silicone
brown	None, self-coloured	WAY	Fluorosilicone
brown	None, self-coloured	WAZ	Fluorosilicone
red	None, self-coloured	WAW	Thermo plastic I.C.I. Welvic

CAUTION: THIS SEALING RING MUST ONLY BE USED ON TRANSPORTATION PARTS

34406

Fig.1

2. Lubrication

A. The lubrication of rubber sealing rings after fitting, to ease the assembly of a unit or part, depends upon the system to which the ring is to be fitted. To prevent premature swelling of sealing rings taking place, use the recommended lubricant in small quantities immediately before fitting the unit or part.

B. The lubricants to be used for sealing ring lubrication are as follows:

Application of sealing ring	Lubricant
Sealing rings in oil systems	Engine lubricating oil (12-12-01)
Sealing rings in fuel systems	Liquid paraffin (B.P. or U.S.P.) Petroleum jelly
Silicone rubber seals in air systems	None
Fluorocarbon seals in air systems	Engine lubricating oil (12-12-01)

NOTE: To prevent damage to inflexible seals manufactured in SE/DTA or WAF coded materials used in air systems, light lubrication using engine lubricating oil (12-12-01) before fitting is permissible.

3. Fitting

A. Use new rubber sealing rings when assembling units or parts.

B. Ensure that the shelf life and condition of the sealing rings are as detailed in 70-61-01.

C. Ensure that grooves and mating faces, to which the sealing rings are to be fitted, are clean, smooth and free from damage. When fitted, check that the sealing rings are not twisted and are correctly seated in the grooves.

D. Do not fit rubber sealing rings to any section of the engine whilst it is still hot, as the sealing rings may stretch and be more liable to damage.

E. To prevent damage to sealing rings when fitting to double grooved ferrules, use a suitable pilot and sleeve assembling tool.

F. Fit rubber sealing rings dry, with the exception of those manufactured from SE/DTA or WAF coded materials. Immediately before assembling the mating parts, sparingly lubricate the exposed surfaces with the appropriate lubricant. Rubber sealing rings in SE/DTA or WAF coded materials are inflexible; therefore, light lubrication of their entire surfaces will greatly assist fitting.

G. Use a straight push to fit ferrules and tubes into their mating sockets; this will prevent twisting and damage to the rubber sealing rings.

R HANDLING OF COMPONENTS CONTAINING THORIUM (MATERIALS KAJ, KAD, KBJ)

R 1. General

R Thorium is a naturally occurring element which is slightly
R radioactive. The principal radioactivity, and therefore major
R potential hazard, is alpha radiation. This is a short range,
R non-penetrative radiation stopped by clothing, gloves etc.
R and is non-hazardous to persons removing, installing and
R handling components.

R WARNING: CARE MUST BE TAKEN TO AVOID INHALATION OR INGESTION
R OF METALLIC DUST OR FUMES INTO THE BODY WHEN REPAIR
R OPERATIONS INCLUDING MACHINING, WELDING, DRESSING,
R FILING AND POLISHING ARE CARRIED OUT.

R The use of dust extractors and efficient hygiene practices is
R necessary and work involving thorium must be carried out in
R accordance with any applicable local regulations.

FITTING VEE BAND COUPLING CLAMPS

1. General

Vee band coupling clamps are used in conjunction with 20 degree Vee flanges to secure units and tubes, and use E type or rubber seals to form air or fluid tight joints in ducts and tubes.

All coupling clamps incorporate 'fail safe' devices, which in the event of failure of the securing bolt(s) will prevent the clamp from opening and thereby retain the integrity of the joint or securing feature.

2. Removal of coupling clamps

A. Avica

(1) Refer to fig.1, unscrew nuts (3) until level with top of bolts (6).

(2) Slide link (5) until washer (4) is clear of lug in free end of top half clamp (1).

(3) Swing bolt (6), together with link (5) and washer (4), out of engagement with free end of half clamp (1).

(4) Open half clamps (1) and (7) and remove clamp from Vee flanges.

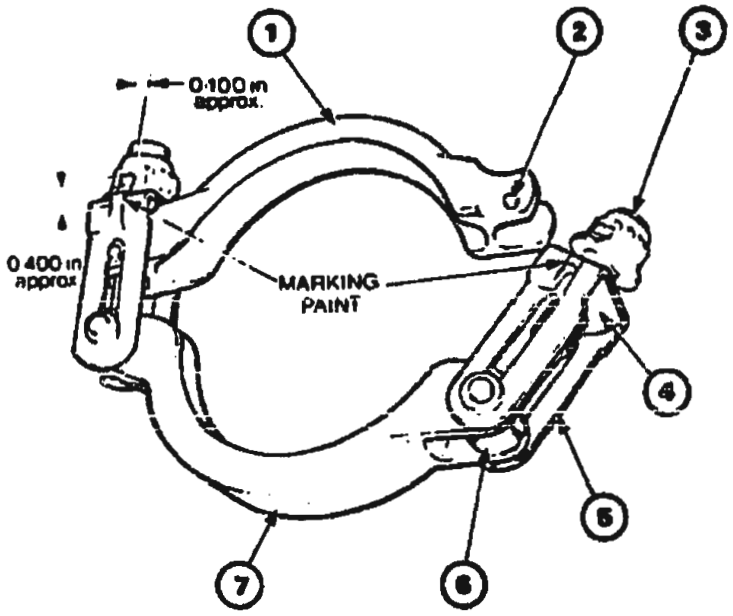
NOTE: If difficulty is experienced in removing the clamp by hand, gently tap the lug ends of the half clamps with a soft faced mallet.

B. Porter

(1) Refer to fig.1, unscrew nut (1) from Tee bolt (2) and remove

(2) Release 'fail safe' device by passing strap end tongue (5) through strap end slot (4).

(3) Open clamp by sliding trunnion (3) off bolt (2), then remove clamp.

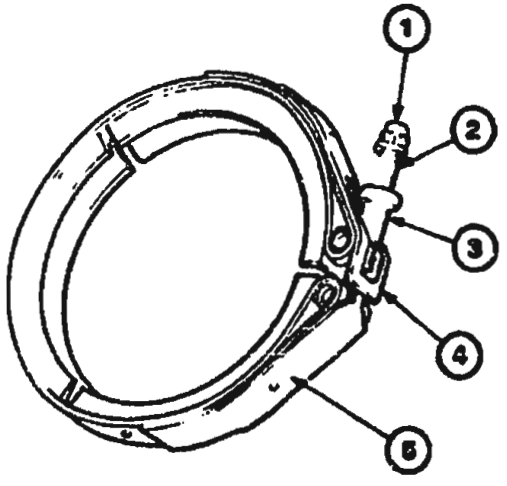


AVICA

1. HALF CLAMP TOP
2. PIN (2 OFF)
3. NUT SELF-LOCKING (2 OFF)
4. WASHER SADDLE (2 OFF)
5. LINK. FAIL-SAFE (2 OFF)
6. BOLT (2 OFF)
7. HALF CLAMP. BOTTOM

PORTER

1. NUT SELF-LOCKING
2. TEE BOLT
3. TRUNNION
4. STRAP END SLOT
5. STRAP END TONGUE



24700A

Vee band coupling clamps removal/installation
Fig.1

3. Prepare for installation

A. Coupling clamps and Vee flanges

(1) Materials required:

	British spec:	American spec:
White spirit:	B.S.245	
or		
Stoddard solvent:		A.S.T.M.D484-52

	British spec:	American spec:
Dry film lubricant:	E.3699	-

Clean engine oil (Ref. 12-12-01).

(2) Clean coupling clamps and Vee flanges with white spirit, then thoroughly dry. Where E type seals are left in situ in male Vee flange, ensure cleaning fluid does not penetrate external cavity between legs of seal.

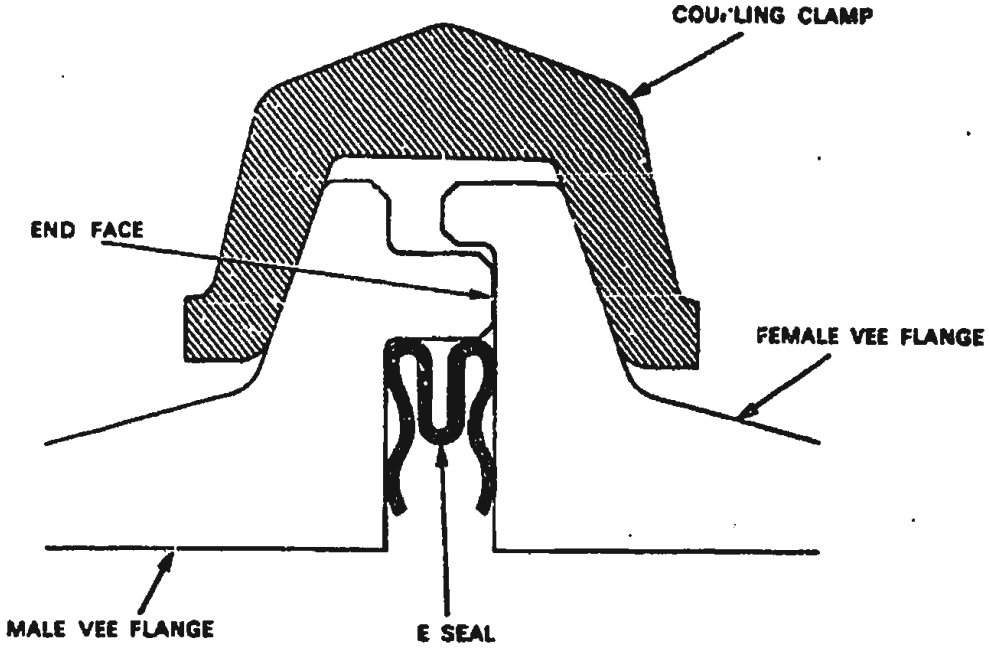
(3) Ensure flanges and clamps are clean and free from corrosion, distortion, cracks (visual), scoring and burrs. On engines not incorporating S.B.71-2195 - Improved E type seals not silver plated - and where E type seals have been used check for silver plating deposits on flanges. If apparent remove by scraping, ensuring parent metal is not damaged.

(4) Fit and lubricate new rubber sealing rings (Ref. 70-02-01) or E type seals (Ref. 3.B.) as applicable.

(5) Inspect dry film lubricant on internal Vee faces of clamps for wear or damage and brush on a new coat if necessary. On clamps that are not dry film lubricated, apply a thin film of clean engine oil.

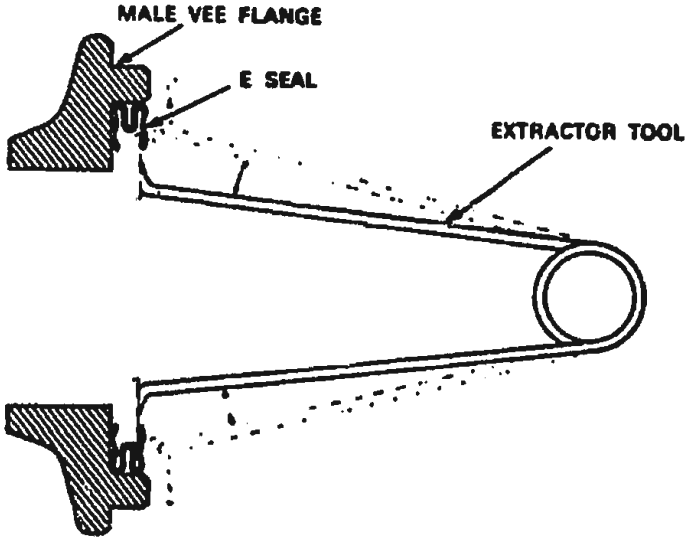
(6) Check run-down torque of self-locking nuts on coupling clamps (Ref. 70-51-00). If not within limits, fit new self-locking nuts.

(7) On Avica clamps used in the following systems - the H.P./I.P. air offtake system (interservices fairing), the engine inlet anti-ice system, the air starter system and the No.2 engine drains system, remove all traces of old marking paint stripes from both self-locking nuts by careful scraping.



Section through duct joint using E type seal
Fig. 2

24701



24702

Fig.2 and Fig.3

B. E type seals

(1) Equipment required:

Extractor tool: AVT.2819 for duct sizes 1in. to 1 3/4in. (25.40mm. to 44.45mm.)
AVT.2820 for duct sizes 2in. to 2 3/4in. (50.80mm. to 69.85mm.)
AVT.2821 for duct sizes 3in. to 4in. (76.20mm. to 101.60mm.)
AVT.2822 for duct sizes 4 1/2in. to 6in. (114.30mm. to 152.40mm.)

NOTE: On engines incorporating S.B.71-2195, extractor tools are not required.

(2) Materials required:

	British spec:	American spec:
White spirit:	B.S.245	
or		
Stoddard solvent:		A.S.T.M.D484-52

(3) Check that outer leg of seal (Ref. fig.2) protrudes beyond end face of male flange.

(4) On engines not incorporating S.B.71-2195, check that silver plating is satisfactory.

(5) If seal does not protrude or if more than 30 per cent of silver plating has deteriorated, fit new seal as follows:

(a) Insert extractor tool (Ref. fig.3) between legs of seal and ease seal free by carefully pulling on tool at several positions around seal until it can be easily extracted.

On engines incorporating S.B.71-2195, insert wooden drift under edge of outer leg of seal and gently extract seal.

(b) Fit new seal into recess in male flange.

NOTE: The seal requires to be manipulated or sprung into the recess, as it is produced 'out-of-round' in order to be self-retaining when fitted. Tools or excessive force must not be used to insert the seal. On engines not incorporating S.B.71-2195, care must be taken not to damage silver plating.

4. Installation of coupling clamps

A. Avica

(1) Equipment required:

Small clean brush

(2) Material required:

Degreasing fluid	British spec. B.S.4487:1969 Genklene
Cleaner	Potassium silicate solution 66 grade
Marking paint	PL.168A

(3) Ensure mating Vee flanges are parallel, centralized and closed.

(4) Refer to fig.1, fit clamp halves (1) and (7) loosely over flanges and press into position.

(5) Swing bolt (6), together with link (5) and washer (4), into slot in clamp lug (1) and simultaneously snap link (5) over pin (2).

(6) Position coupling so that nuts (3) are accessible and that no fouls exist between coupling and adjacent units or structure.

(7) Tighten nuts (3) uniformly to approximately 70 per cent of recommended maximum torque.

(8) Tap outer periphery of clamp halves (1) and (7) with a soft faced mallet to distribute tension.

(9) Tighten nuts (3) uniformly using small increments of torque, until recommended torque value of 120 ± 5 lb.in. is obtained.

(10) On Avica clamps used in the following systems - the H.P./I.P. air offtake system (interservices fairing), the engine inlet anti-ice system, the air starter system and the No.2 engine drains system, apply paint markings for visual indication of correct torque tightening as follows:

(a) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, refer to fig.1 and carefully clean area to be painted on nuts (3).

NOTE: If initial paint application, or existing paint is damaged on links (5) also clean area indicated on fig.1.

(b) Apply cleaner to area previously degreased and allow to air dry for approximately 10 minutes.

(c) Brush apply marking paint to area on nuts (3) specified on fig.1, ensuring paint does not encroach on bolt threads, and allow to air dry.

NOTE: If initial paint application, or existing paint is damaged on links (5) apply marking paint to area specified on fig.1 and allow to air dry.

B. Porter

(1) Ensure that mating Vee flanges are parallel, centralized and closed.

(2) Refer to fig.1, fit clamp loosely over flanges and slide trunnion (3) over Tee bolt (2).

(3) Engage 'fail safe' device by passing strap end tongue (5) through strap end slot (4).

NOTE: The 'fail safe' device must be engaged by the time minimum torque is reached. Under no circumstances shall the maximum torque be exceeded in order to engage the 'fail safe'.

(4) Fit nut (1) to Tee bolt (2) and position coupling so that nut is accessible and no fouls exist between coupling and adjacent units or structure.

(5) Tighten nut (1) to approximately 70 per cent of recommended maximum torque.

(6) Tap outer periphery of clamp with a soft faced mallet to distribute tension.

(7) Tighten nut (1) until recommended torque value of 80 ± 10 lb.in. is obtained.

(8) Slacken and retighten nut (1) twice, to recommended torque value without altering position of clamp, ensuring that 'fail safe' device remains engaged.

EXPLANATION OF GEOMEIRIC TOLERANCING

Introduction

The drawing information on some illustrations in Approved Repairs in this manual incorporates the International Standards Organization (I.S.O.) recommendations on calling out geometric tolerances.

The geometric tolerancing system uses a series of geometrically derived symbols to denote relationship between datum (reference) surfaces and features, to simplify the interpretation of drawing information and minimise language problems.

A component has two basic types of tolerance, SIZE and GEOMETRY.

Geometric tolerances control FORM and POSITION, and the geometric characteristic requirement is portrayed by a symbol instead of a worded instruction.

The basis of the system is a box or frame containing the symbols, tolerances, datums and basic dimensions.

The following series of illustrations each explain the interpretation of one symbol, though circumstances may alter the requirement on actual drawings.

In certain illustrations, a worded instruction, in italics, of the type previously used on drawings is included, the instruction relates only to the interpretation of the particular symbol, and not to any other symbol included as necessary information on the illustration.

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Definitions

1. Geometric tolerance

Tolerances which control FORM and POSITION.

2. Datum

A surface, axis, plane, etc., real or imaginary to which the TRUE POSITION of a feature has relation or is measured from.

3. Basic

Dimensions which define the form of a feature, and/or the theoretically true position of a feature or features.

4. Maximum metal condition Ⓜ

When the volume of material contained by the feature is at its maximum, as governed by its size dimensions, it is said to be at the maximum metal condition, i.e., The largest shaft, pin, tab, etc. The smallest hole, slot, groove, etc.

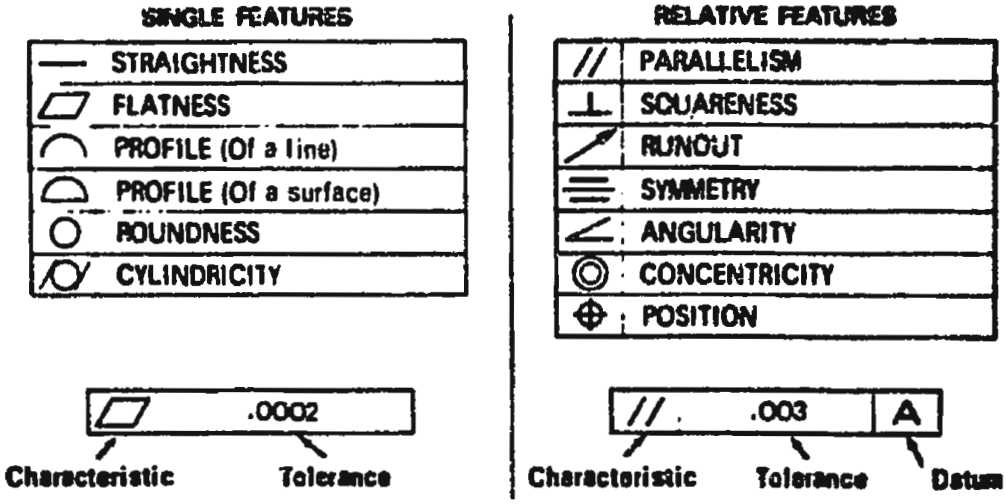
5. Engineering drawing

A document which defines, controls, and identifies a finished manufactured component. (It is not necessarily a working drawing, but MUST be used for FINAL inspection.)

23376

Definitions
Fig.1

Symbol chart (geometric characteristics)



Greek letter Ø (PHI) is abbreviation for diameter.

The SYMBOLS, TOLERANCES and DATUMS are called out in a frame which is connected to the feature requiring geometric control. The dimensions positioning surfaces or features requiring geometrical control have BASIC dimensions and these are identified again by a frame around them.

Of the 13 geometric symbols, six do not require a datum as they only control form and can exist alone, as shown on the example.

The remaining seven are relative features and require a datum as they control position - see right-hand example.

In this system ALL tolerance zones are total in magnitude, and are either a circle, cylinder or sphere or the space between two planes, lines or surfaces, or the space between two concentric cylinders etc.

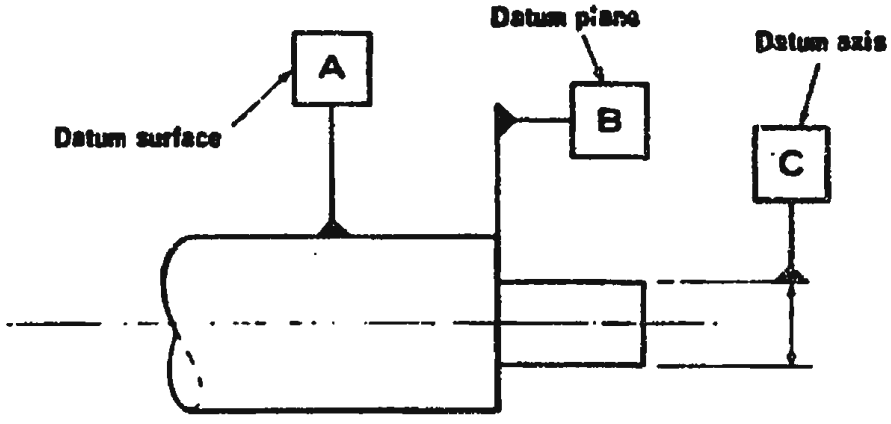
When the tolerance zone is circular in shape the Ø sign will be added in front of the tolerance.

33377

Symbol chart
Fig.2

Datum identification

DATUM is identified by the leader line terminating in a solid triangle



Datum letter 'A', 'B' etc., used as datums in the tolerance frame, are shown on the body of the drawing in a frame. The feature which is datum is identified by a leader line terminating in a solid triangle.

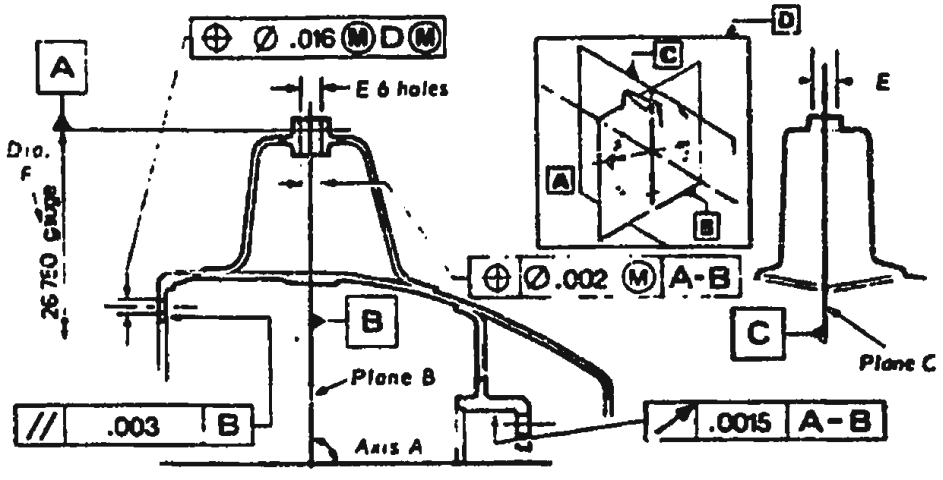
When an axis or plane is required as datum, as opposed to a surface, the leader line and triangle are opposite and in line with a dimension line across the part. The dimension line may or may not carry the size dimension.

It is important to appreciate that datums on drawings are derived from Design features i.e., bearing locations, spigots, dowel holes, joint faces, etc. The drawings specify what the engine will accept, but if the drawing datums are not practical for inspection, then other arrangements must be made by manufacturing providing the design requirements are not impaired.

23378

Datum identification
Fig.3

Datums (theoretical)



Axis A established by axis of diameters E at gauge dia. F. Plane B established by axis diameters E, square to axis A. Plane C established by axis A and axis dia. E. Axis A, planes B & C are datum for all features unless otherwise specified.

The DESIGN DATUM is derived from an actual feature of the part, such as the surface of a facing or diameter. These features may then be used to locate the part during the inspection process.

There are a number of occasions when THEORETICAL DATUMS must be specified, but although theoretical in concept they are derived from actual features, and are made tangible by the inspection fixture.

The diagram shows such an example.

Datum A is an AXIS found by passing a series of pins through an inspection fixture, and locating the casing by the 6 holes in the spoke bosses.

Datum B is a PLANE found by the same pin/fixture method.

Datum C is a PLANE found on the fixture by the axis derived at the gauge diameter of the pins, and timed by the pin at the top centre.

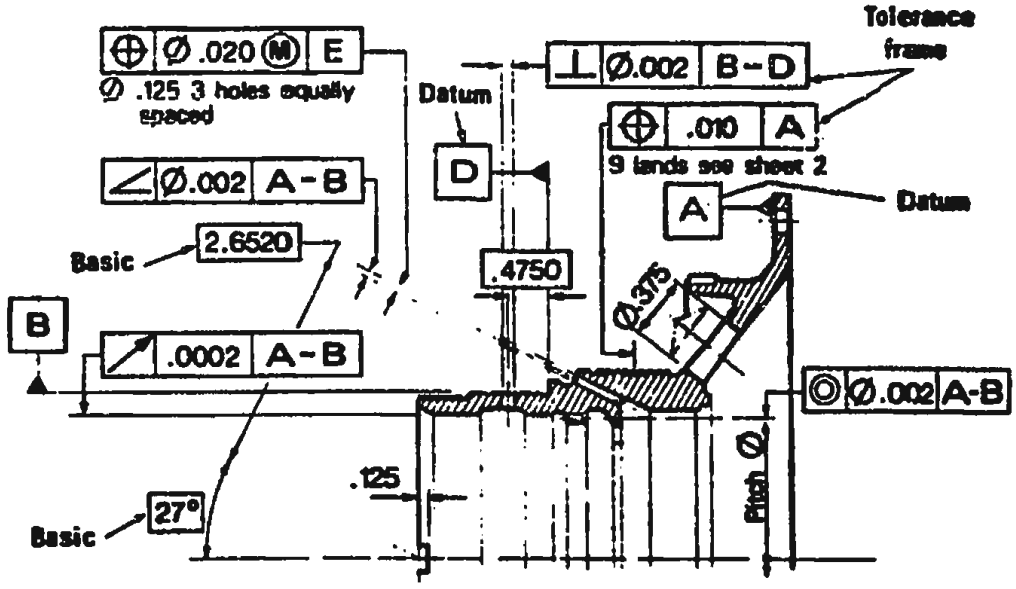
The 3 geometric requirements shown on the diagram may be considered as follows:

1. Parallelism of the flange face within 0.003 in., in relation to the fixture (via the pins which have established plane B).
2. Runout of the inner flange surface of 0.0015 in. (clock indicator reading) in relation to an axis of rotation about the gauge diameter A, which is square to the plane B, on the fixture (Zero swash on plane B).
3. Position of the holes shown in the flange is related to all 3 datums, and the " 3 Datum Concept " is used; refer to fig. 21.
4. Position of the holes in the spoke bosses are relative to the theoretical datums A and B.

23379

Datums (theoretical)
Fig.4

Sample drawing

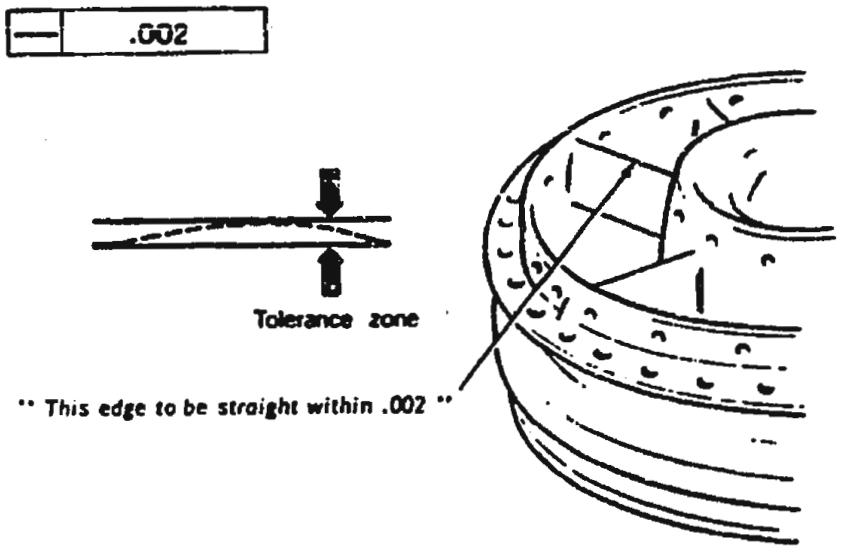


This illustration shows part of a drawing using the geometric tolerancing system, with tolerance frames, datums and basic dimensions contained in frames.

23380

Sample drawing
Fig.5

Straightness

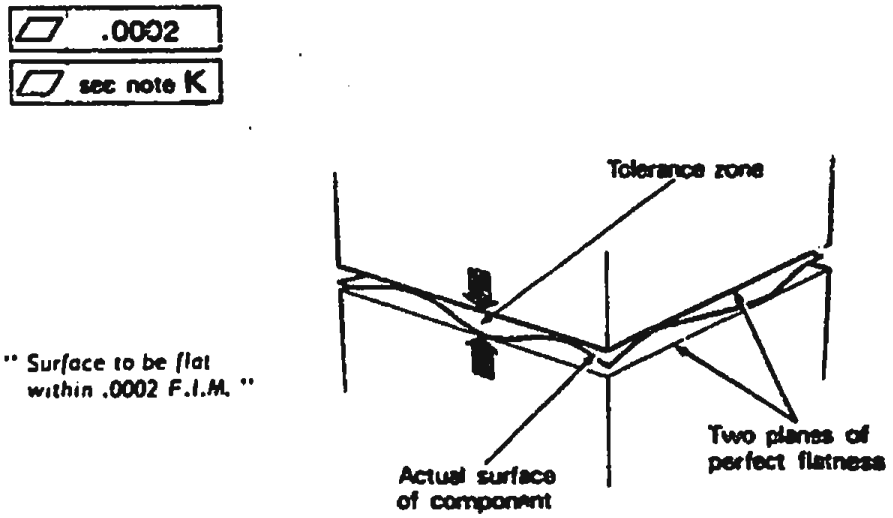


This tolerance frame means that the edge of the feature must lie within a tolerance zone contained by two straight lines 0.002 in. apart.

23381

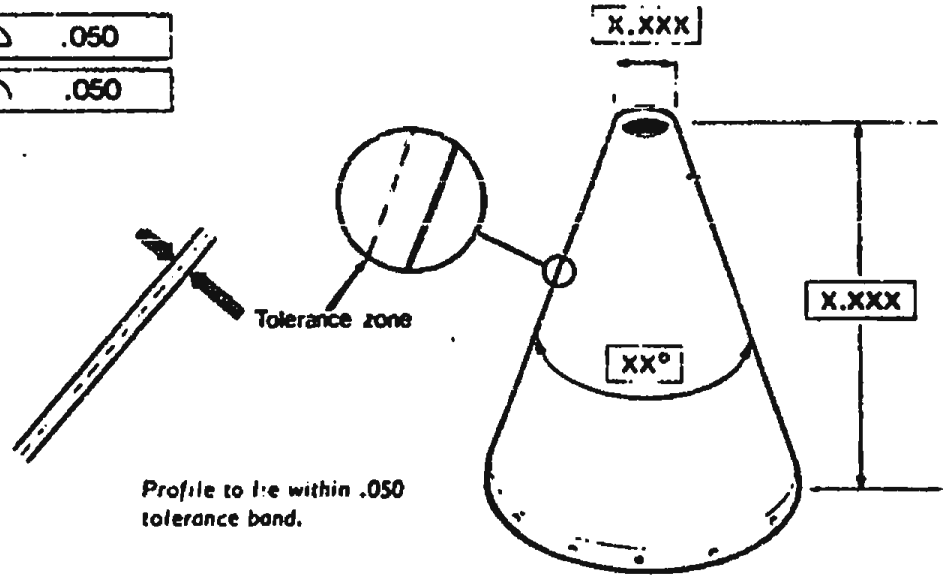
Straightness
Fig.6

Flatness



This diagram shows that the actual surface of the feature must lie within two perfectly flat and parallel planes the tolerance zone apart. However, when a flatness of high precision is required, the tolerance magnitude portion of the frame will carry a reference to a note, e.g. " See Note 'K' ".
Note 'K' would spell out in words " blue bed checking with % contact " or " light band " method of controlling flatness.

Flatness
Fig.7



This diagram shows two symbols. The top one for profiles of features which have surface area, the lower one for lines such as stations through sheet metal parts, etc.

The interpretation is the same for each symbol, and in the example shown the surface of the feature must lie within a tolerance zone 0.050 in. wide which is centred on the basic form

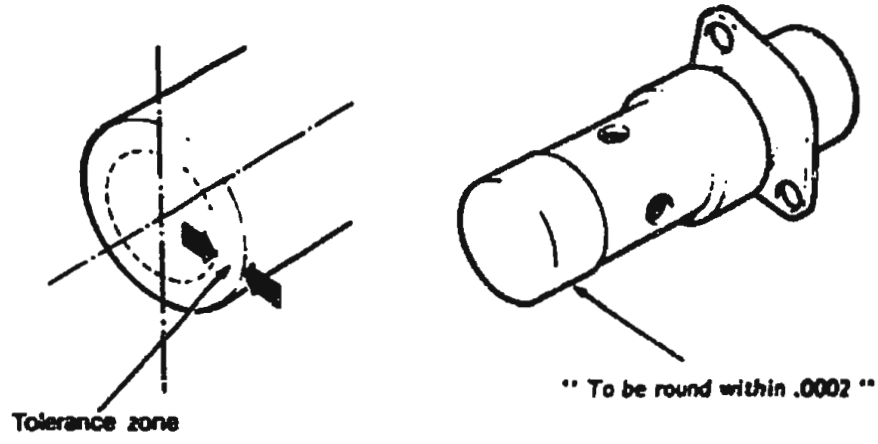
If it is a requirement that the tolerance zone shall be in a plus or minus direction, then a separate view will be shown to indicate this, otherwise the total tolerance will be equally spaced about the basic form. Profile tolerances may control size as well as form.

23383

Profile
Fig.8

Roundness (circularity)

○	.0002	Edges



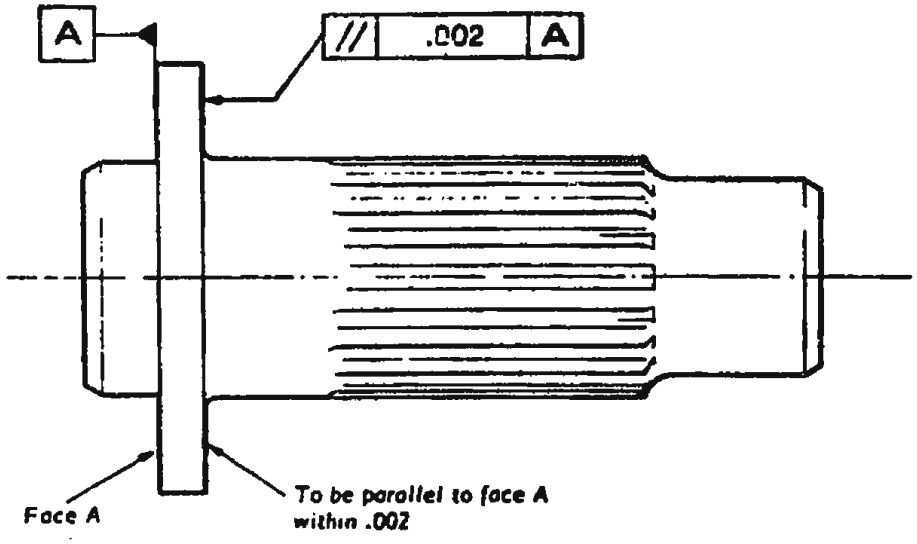
This diagram shows the symbol for roundness (CIRCULARITY) as used to control lines or edges.

The surface or edge of the feature being controlled must lie within a tolerance zone which is an annulus formed by two perfectly round and concentric circles which have a radial separation of the tolerance specified.

23384

Roundness (circularity)
Fig.9

Parallelism



This is the first of the RELATIVE features and the frame now has 3 parts, the 3rd one being for the datum letter.

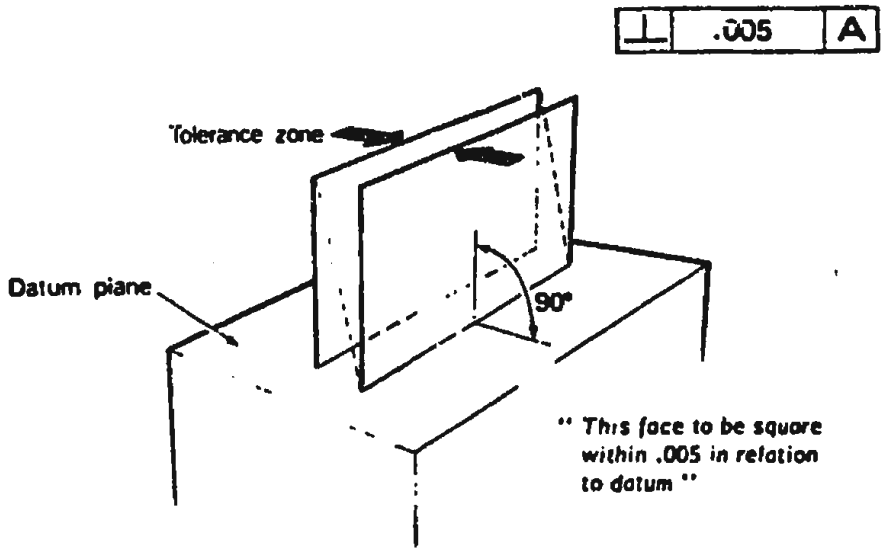
The meaning here is that the feature must lie within a tolerance zone of two planes perfectly parallel to the datum A, and 0.002in. apart.

The datum surface is indicated by the letter A in a frame and the leader line terminating in the Solid Black triangle.

23385

Parallelism
Fig.10

Squareness



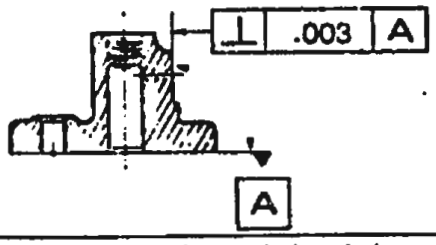
This diagram shows that the actual surface being controlled must lie within two planes 0.005 in. apart, which are of perfect squareness in relation to the datum face

23386

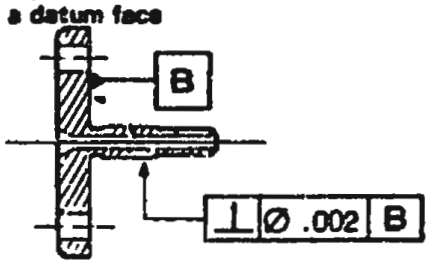
Squareness
Fig.11

Squareness (perpendicularity)

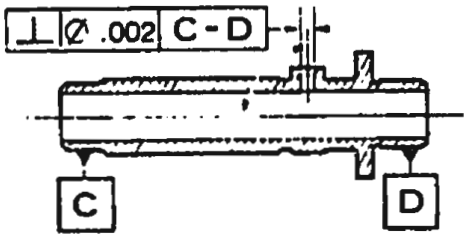
1. Squareness of a face in relation to a datum face



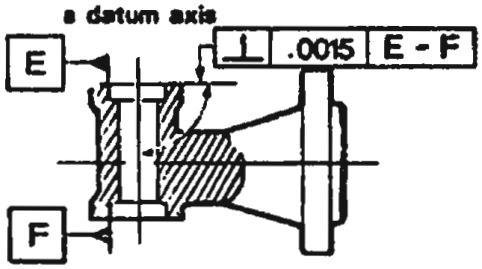
2. Squareness of an axis in relation to a datum face



3. Squareness of an axis in relation to a datum axis



4. Squareness of a face in relation to a datum axis



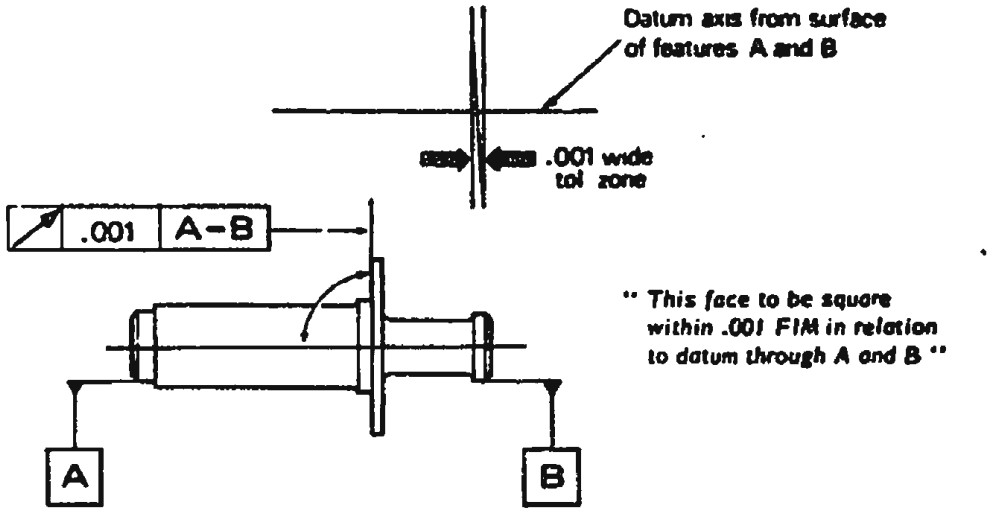
With squareness there are different types of features which require a squareness control.

1. Squareness of a face in relation to a datum face.
2. Squareness of an axis in relation to a datum face.
3. Squareness of an axis in relation to a datum axis.
4. Squareness of a face in relation to a datum axis.

23387

Squareness (perpendicularity)
Fig.12

Runout (face squareness control)


Datum axis from surface of features A and B
.001 wide tol zone
.001 A-B
" This face to be square within .001 FIM in relation to datum through A and B "
A
B

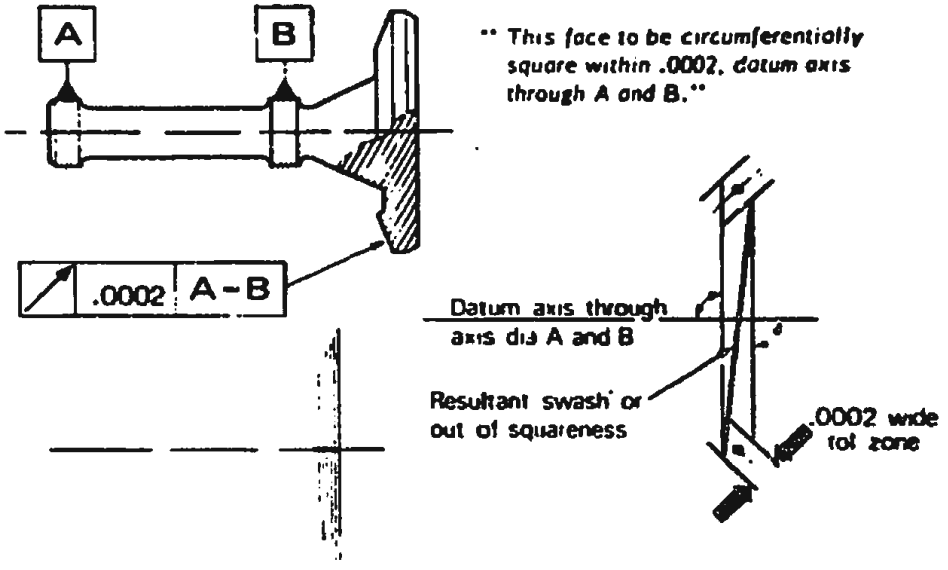
There are many instances where it is a functional requirement to control the squareness of faces on shafts such as the one indicated. The whole surface of the face must be contained within a tolerance zone, 0.001 in. wide, which is of perfect squareness to the datum.

The symbol - RUN OUT takes into account swash, flatness, or perpendicularity, provided the sum of these does not exceed the specified tolerance. RUN OUT symbol will be used , on parts which can be rotated about the datum feature during inspection, when a combination of these defects can be accepted during one complete revolution without axial movement.

23388

Runout (face squareness)
Fig.13

Runout (circumferential squareness)


A
B
.0002 A-B
** This face to be circumferentially square within .0002, datum axis through A and B.**
Datum axis through axis dia A and B
Resultant swash or out of squareness
.0002 wide tol zone

For parts with CURVED or CONED faces that require a circumferential squareness control, the runout symbol is used.

This is virtually controlling the squareness of an infinite number of flat circular planes (which make up the coned or curved surface as indicated in the lower left corner).

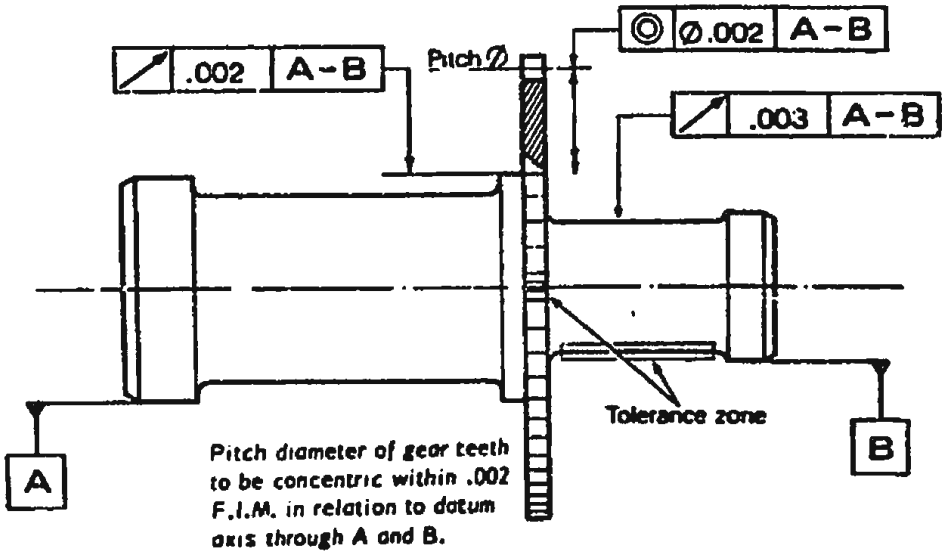
Each individual imaginary plane may have SWASH, be out of SQUARE, or ECCENTRIC, or out of ROUND, or a combination of all or any two of these defects. In practice it is not usually necessary to separate these defects, hence the use of the combined toferance.

The diagram shows an enlarged view of the deviation of one of the selected points.

23389

Runout (circumferential squareness)
Fig.14

Concentricity


.002 A-B
Pitch Ø
⌾ Ø.002 A-B
.003 A-B
Tolerance zone
A
B
Pitch diameter of gear teeth to be concentric within .002 F.I.M. in relation to datum axis through A and B.

This diagram shows the symbol for concentricity as two concentric circles, the tolerance zone is a Ø 0.002 in. cylinder centred on the datum axis A-B, and the axis of the feature being controlled must lie within this tolerance zone.

NOTE: The datum axis of rotation is derived from the " Surface " of the diameters A and B. Irregularities in the form of the feature often make it difficult to establish the axis of the feature. For instance, a nominally cylindrical surface may be bowed or out of round in addition to being offset from the datum; in such cases finding the axis of the features would prove difficult and time consuming.

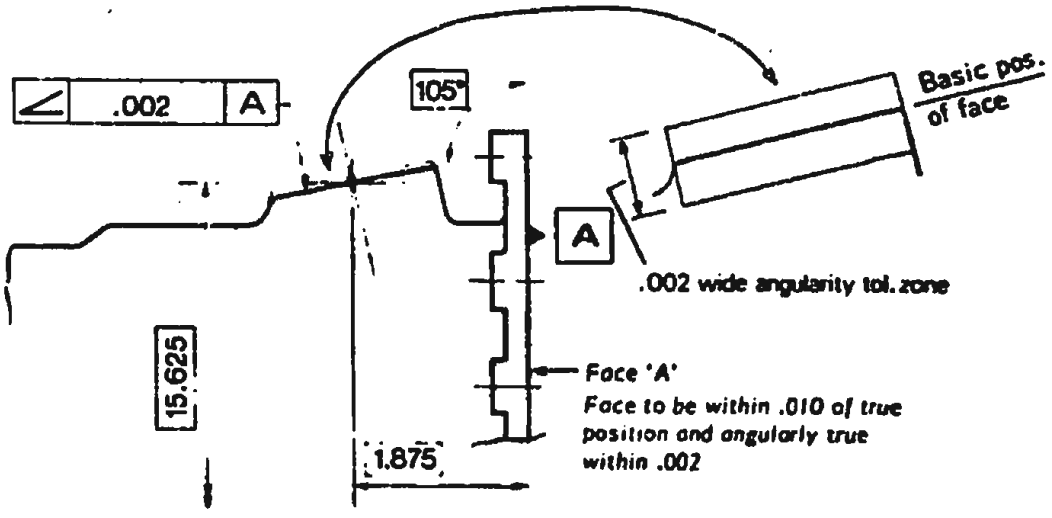
Therefore, unless there is a definite need for the control of axis, it is recommended that the control be specified as runout.

NOTE: This diagram also shows the difference between CONCENTRICITY (control of axis) and RUNOUT (Control of Surface).

23390

Concentricity
Fig.15

Angularity



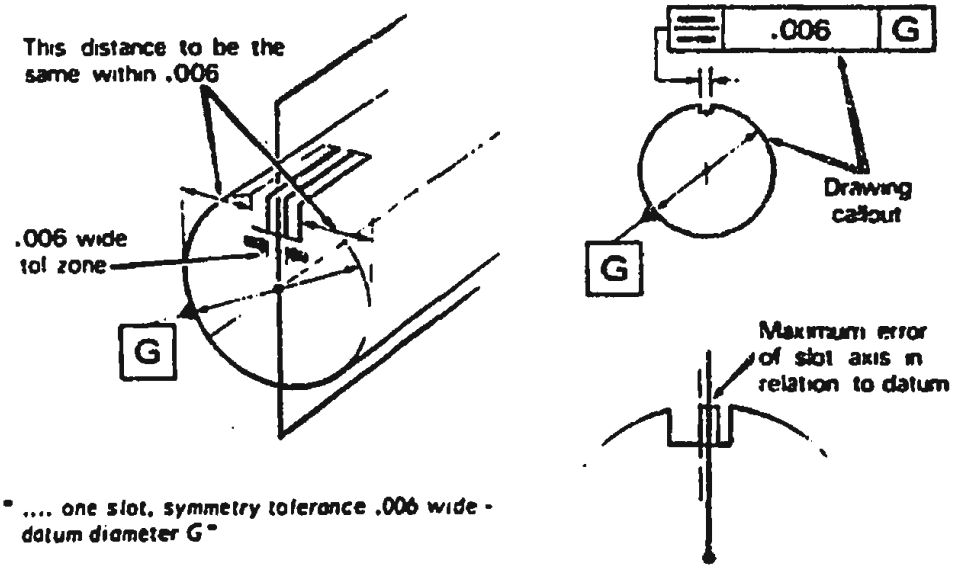
This symbol means that the angular truth of the feature must be contained within two planes, 0.002 in. apart, at the absolute true basic angle in relation to the datum.

If coupled with a coarse position tolerance, the angularity tolerance zone must be contained within the position tolerance zone. This is shown in the right-hand corner of the diagram.

23391

Angularity
Fig.16

Symmetry



" .... one slot, symmetry tolerance .006 wide - datum diameter G"

It may be necessary to control the symmetry of a feature in relation to some datum.

The diagram shows the symmetry symbol, the total tolerance zone and the datum, the example being a slot in a shaft. The meaning of the I.S.O. frame is the same as the note - see bottom left. **The axis of the slot must be contained within a 0.006 in. wide tolerance zone centred on the datum plane through the axis of the shaft.**

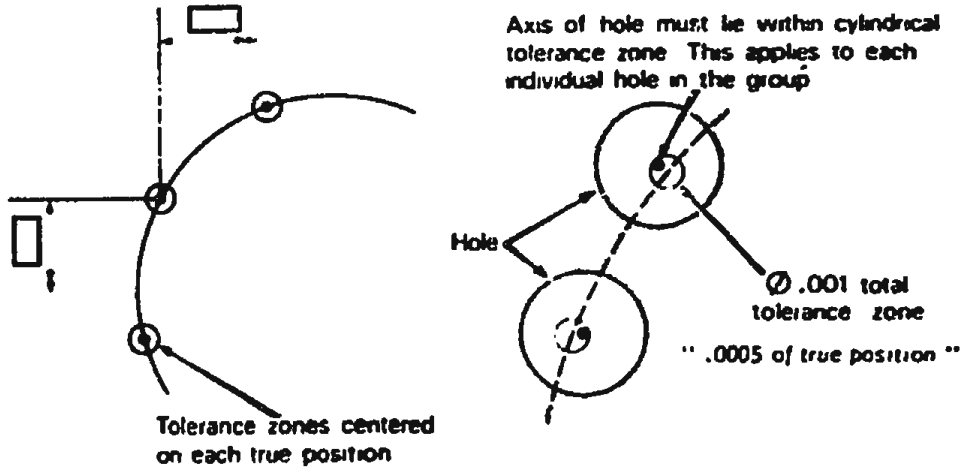
In other words the distance either side of the slot as shown must be the same value within 0.006 in.

NOTE: Symmetry although acceptable in certain conditions, has limited application, position being a more practical and economical way of controlling slots by using the maximum material principle.

23392

Symmetry
Fig.17

Position-fundamentals of hole tolerancing

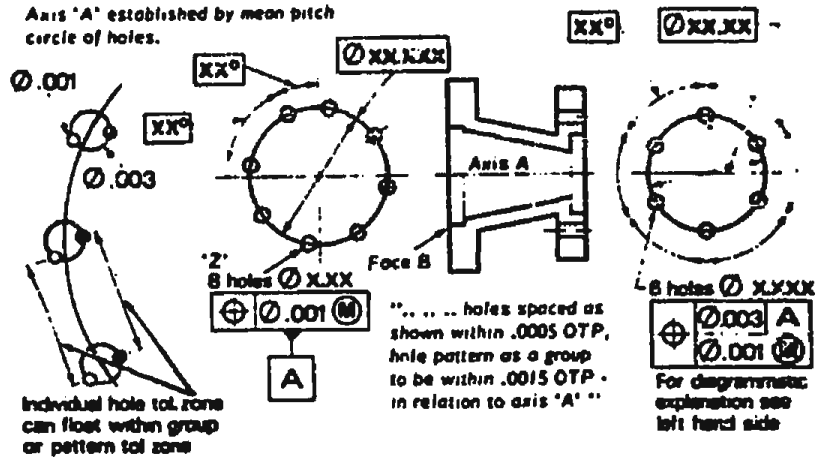

Axis of hole must lie within cylindrical tolerance zone This applies to each individual hole in the group
Hole
Ø .001 total tolerance zone
" .0005 of true position "
Tolerance zones centered on each true position

This example shows a number of holes having a common pitch circle.Each hole has its own TRUE POSITION fixed by the BASIC dimensions, with the axis of the hole positioned within 0.0005 in. of true position. The geometric tolerancing system is such that ALL tolerances are total in shape and magnitude. Thus the tolerance is shown as 0.001 in. diameter.

23399

Position - fundamentals of hole tolerancing
Fig.18

Position - individual, plus group or pattern tolerance


Axis 'A' established by mean pitch circle of holes.
Ø.001
XX°
Ø.003
XX°
ØXX.XX
'Z'
6 holes Ø X.XX
Ø.001 M
A
Face B
Axis A
".. .. .. holes spaced as shown within .0005 OTP, hole pattern as a group to be within .0015 OTP - in relation to axis 'A' "
Individual hole tol. zone can float within group or pattern tol zone
XX°
ØXX.XX
6 holes Ø X.XXX
Ø.003 A
Ø.001 M
For diagrammatic explanation see left hand side

(a) A requirement, particularly on engines where the casings are used as the engine backbone, is to use the holes in the flanges as centralizing features. This is necessary to ensure that main bearing journals and shafts and seals are correctly aligned, and running concentrically with correct clearances.

The I.S.O. system has been adapted to call out the holes as a datum by the letter 'A' and leader line etc., connected to the tolerance frame for the holes in question. (Bottom left of diagram).

The word meaning is that., the datum A is the axis of the mean circle of the holes.

(b) It is often a requirement to have TWO tolerances for the same feature, that is the holes in the right-hand flange will require,

1. Tolerances of position for each individual hole on the pitch circle.
2. Tolerance of position for the pattern as a whole, in relation to some datum.

The two requirements are specified by the frame system. At the bottom right, the frame has been split to call up these two requirements.

NOTE: There is no significance in which way round the information is stated in the large frame.

(c) Read the information in the frame and compare it with the word callout, also noting the letter (M) which will be discussed fully, later in the text.

1. The lower part of the frame - " Position 0.001 in. dia. tolerance zone for each of the 6 holes " - there is, in this case, no datum, as the whole group will have relation to a datum.

This compares with the first portion of the note, " ——— holes ——— within 0.0005 in. of true position. "

Note the I.S.O. TOTAL tolerance zone of Ø 0.001 in., and that the word true position 0.0005 in. is HALF the total tolerance zone.

2. The upper part of the frame - " Position 0.003 in. dia. tolerance zone datum feature A. "

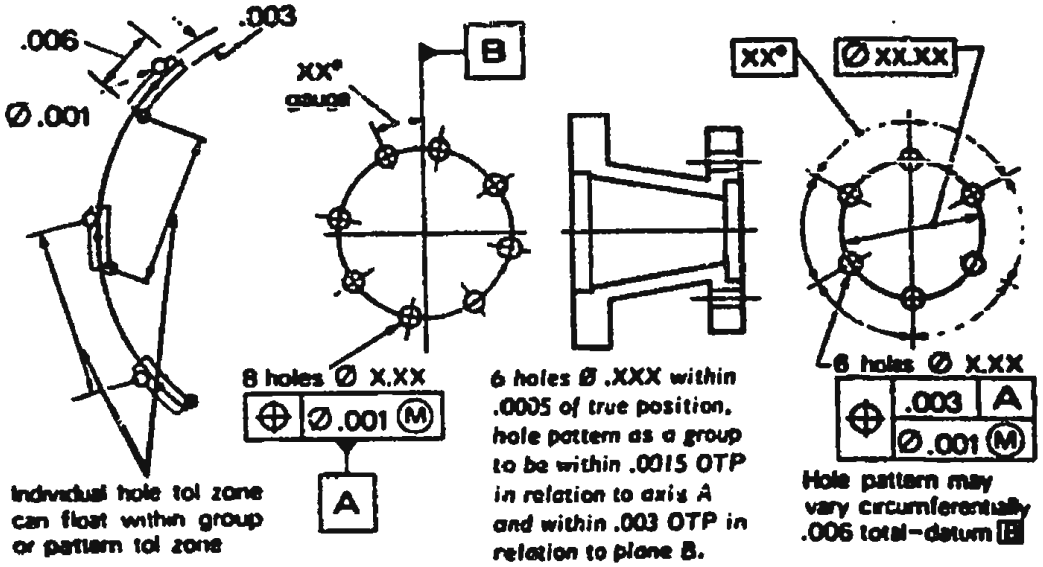
This must be the group or pattern tolerance of the 6 holes in relation to the datum A, 'A' being the mean pitch circle of the hole on the other flange as previously discussed.

This compares with the second portion of the note " hole pattern as a group within 0.0015 in. to axis 'A'. "

Note the I.S.O. TOTAL tolerance zone of Ø 0.003 in. and that the word true position of 0.0015 in. is HALF the total tolerance zone.

Position - individual, plus group or pattern tolerance
Fig.19

Position - individual, plus group or pattern, and circumferential tolerance


.006
.003
Ø.001
Individual hole tol zone can float within group or pattern tol zone
XX° gauge
B
8 holes Ø X.XX
Ø.001 M
A
6 holes Ø .XXX within .0005 of true position, hole pattern as a group to be within .0015 OTP in relation to axis A and within .003 OTP in relation to plane B.
XX°
ØXX.XX
6 holes Ø X.XX
.003 A
Ø.001 M
Hole pattern may vary circumferentially .006 total-datum B

(Individual plus group or pattern, and circumferential tolerance)

There are occasions when a third tolerance of position for the same feature will be necessary, as shown on this slide:

1. Position for each individual hole.
2. Position for the group or pattern in relation to an axis datum.
3. Position for the group or pattern in relation to a plane datum.

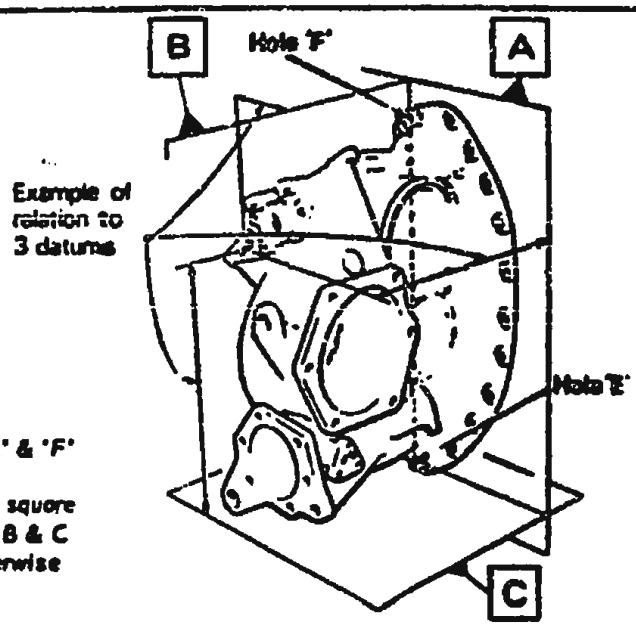
Items (1) and (2) are as the previous diagram, but item (3) will be controlled by a note as shown. This would generate a tolerance zone of 0.003 in. × 0.003 in. total for the group as shown on the left-hand side, but obviously each hole must firstly obey the individual hole tolerance zone.

The diagrammatic view indicates the tolerance magnitude in relation to the axis and a coarser magnitude in relation to the timing plane, with the overriding fine tolerance for individual hole position.

23401

Position - individual, plus group or pattern and circumferential tolerance
Fig.20

3 Datum concept



Plane B established by axis holes 'E' & 'F' square to face A.
Plane C established by axis hole 'E' square to face A & plane B. Face A, planes B & C are datum for all features unless otherwise stated.

It is a requirement on certain engine components that the true position of the features require to be measured three-dimensionally, that is to say:

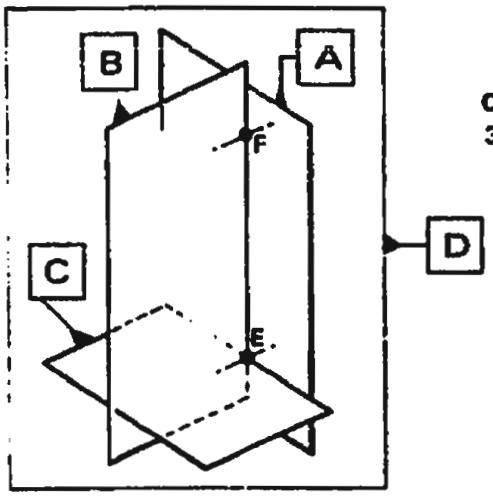
1. axially along the part from the face,
2. in a direction from an axis or plane,
3. angularly in relation to some feature.

It follows that to inspect the part and also to manufacture it, the drawing reader must always consider the part when it is placed in a particular attitude. This position is invariably the " as in engine situ. " The previous system of controlling this was by means of quite complex notes as shown on the next diagram. These suffer in translation and a simpler solution is required.

23402

Three datum concept
Fig.21

Datum concept



Collective datum of 3 datum concept

The various salient features are shown pictorially in the attitude required, and enclosed in a frame. This frame is given a letter for use as a datum.

When letter [D] is used elsewhere on the drawing as a datum in one of the tolerance frames, the feature must be considered with the part orientated as shown in this 3-datum concept.

A, B and C can still be used as separate datums as required.

23403

Datum concept
Fig.22

Maximum metal condition

1 ⌖ | Ø .004 Ⓜ | A

a) This tolerance only applies at maximum metal condition when Ⓜ is shown

b) This tolerance can be increased by the diametral increase in size of feature when Ⓜ is shown

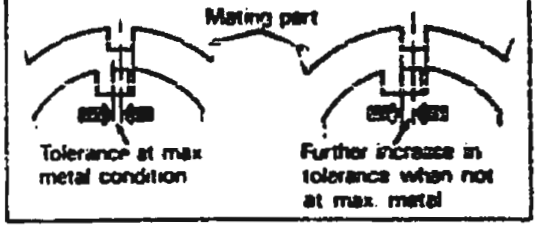
2 ⊕ | Ø .004 | A Ⓜ

When Ⓜ is not shown this tolerance applies regardless of feature size

3 ⊕ | Ø .004 Ⓜ | A Ⓜ

Maximum metal condition applied to feature and datum

Ⓜ Example for position of a slot



The engineering drawings are dimensioned and toleranced to control the parts at the worst conditions of fit for assembly, that is to say the largest shaft and the smallest hole condition. It follows that a geometrical tolerance, when parts are at their worst conditions of fit, must be adhered to, but when the parts move away from the Maximum Metal Condition (that is in the direction of metal off) a larger geometrical tolerance can be allowed. In order that this requirement can be applied to give manufacturing easement at the inspection stage, the letter Ⓜ is added in the tolerance frame as shown in the frame 1 on the diagram.

To summarise, the 0.004 in. tolerance must be maintained when the part is at its Maximum Metal Condition, but if some metal is removed into the size tolerance, the 0.004 in. can be increased by the amount of metal removed. This easement can only take place if Ⓜ is shown.

This condition is particularly applicable to the position of holes, slots and concentricity. As an example of this, consider the castings being checked for position with undersize pins. If it is difficult to push the pins in it may be that they have exceeded their positional tolerance, but can still be accepted providing metal is removed to allow the pin to pass into the hole. It is obvious that the amount of metal removed must not be in excess of the size tolerance.

If a 2.000 ± 0.001 in. bore measures 0.0015 in. error during a position check, and the drawing calls for 0.0005 in., this is acceptable if the bore size measures 2.001 in.

There are occasions when any extension of the geometrical tolerance cannot be allowed, in which case the Ⓜ would not be indicated, see frame 2 on diagram. An instance of this is interference fitting holes and tapped holes.

Again there will be instances where inspectional easement can be obtained by applying Ⓜ to the datum feature, in which case the Ⓜ will be added to the datum letter as shown in frame 2. Frame 3 shows the Maximum Metal Condition applied to both feature and datum.

23404

Maximum metal condition
Fig.23

SHANK NUTS

REPLACEMENT OF DAMAGED SHANK NUTS

FRS.3034

1. Effectivity

I.P.C. Fig./Item	Part No.
All shank nuts	See Parts Catalogue for part numbers

2. Deleted

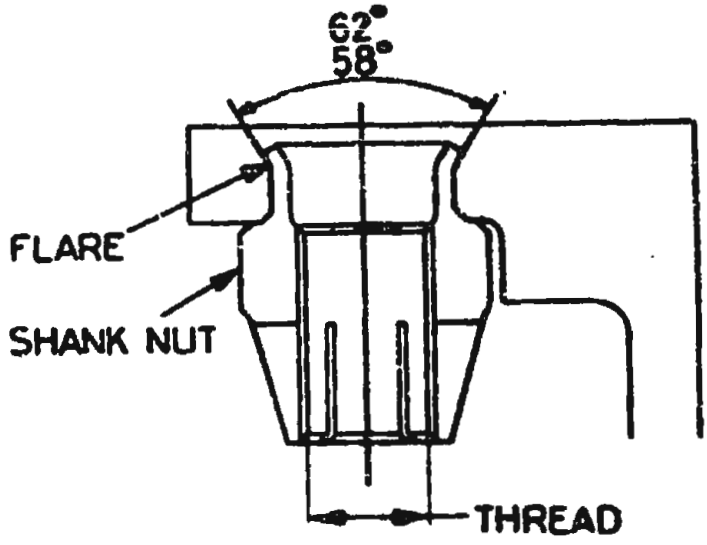
3. Instructions

A. Remove shank nuts

Procedure	Supplementary information
(1) Drill flare until it collapses; remove nut	See fig.1
(2) Clean and inspect nut location in component	

B. Fit new shank nut

(1) Fit shank nut	
(2) Support nut and form flare	See fig.1 Tool: Select from Item 1 to 5



Unified thread size (in.)	Drill size in millimetres (inch conversion in parenthesis)
0.190 (No. 10)	5,7 (0.224)
0.250	8 (0.315)
0.3125	9,6 (0.378)
0.375	11,5 (0.453)
0.500	14 (0.551)

Typical section through shank nut
Fig.1

4. Tools

Description	Tool No.	Item
Peening tool No.10 UNF	HU.19641	1
Peening tool 0.250in UNF	HU.19648	2
Peening tool 0.312in UNF	HU.19655	3
Peening tool 0.375in UNF	HU.19657	4
Peening tool 0.500in UNF	HU.19547	5

5. Parts

A. Parts required

I.P.C. Fig./Item	Part No.
Shank nuts	See Parts Catalogue for part numbers

6. Price and Availability

Engine parts)
) Refer to Rolls-Royce
Repair of spares)

REPLACEMENT OF STUDS FITTED IN LIGHT ALLOY MATERIAL

FIT OVERSIZE STUDS (FAST END ONLY)

ERS.3000

1. Effectivity

I.P.C. Fig./Item	Part No.
All light alloy components in which studs are fitted	See Parts Catalogue for part numbers

2. Repair status

This repair has been proved practically.

3. Instructions

A. Studs 0,05 mm. (0.002in.) and 0,1 mm. (0.004in.) oversize on the fast end can be fitted to obtain the required interference without re-tapping when the thread in the case is not damaged.

B. Fitting studs which are a complete thread oversize is covered by a separate Repair.

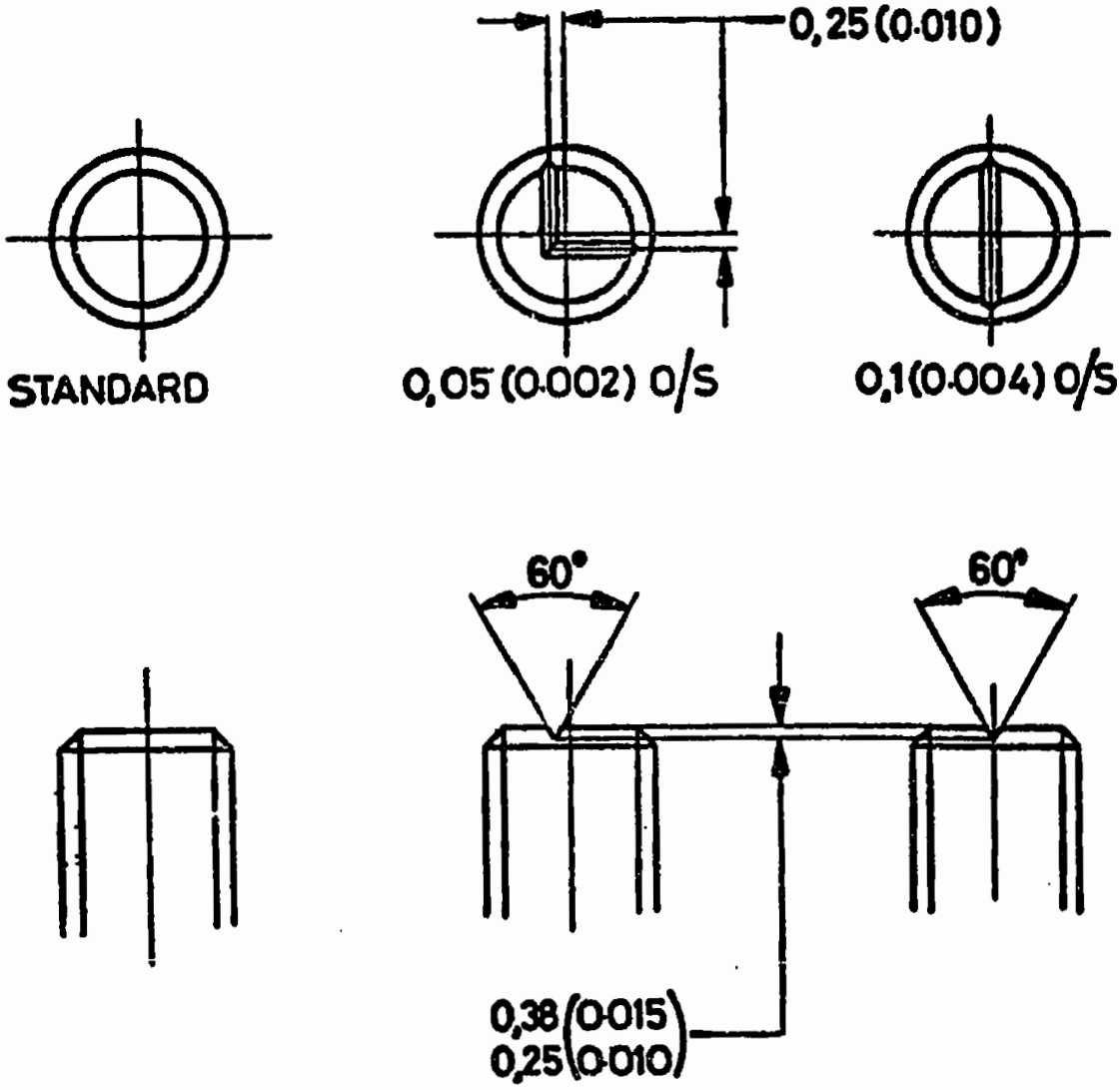
C. Required interference.

Stud effective diameter	Interference
6,35 mm. (0.0250in.) to 11,1125 mm. (0.4375in.)	0,05 mm. (0.002in.)
Over 11,1125 mm. (0.4375in.)	0,0635 mm. (0.0025in.)

D. Identification of oversize studs

The actual parts are identified as illustrated in fig.1.

THE OVERSIZE END OF EACH STUD IS IDENTIFIED AS SHOWN BELOW.



Method of identifying oversize studs
Fig.1

The part numbers in the Parts Catalogue are suffixed as follows:

0,05 mm. (0.002in.) oversize - suffix P
0,1 mm. (0.004in.) oversize - suffix E

4. Tools

Special tools are not required.

5. Parts

A. Parts required

I.P.C. Fig./Item	Part No.
Oversize studs as required	See Parts Catalogue for part numbers

R # REPAIR OF SURFACES AFFECTED BY MINOR DAMAGE

R # FRS.3253

R 1. General

R This section describes the repair of minor damage which may
R affect parts during service. It is important however, that
R these minor repairs are applied only when instructed in the
R relevant inspection chapters.

R Parts repaired to the following instructions must be restored
R to as near their original shape as possible, must not exceed
R the worn dimension limits detailed in Fits and Clearances and
R the surface protection restored as described in 70-42-12.

R 2. Repair of scores, galling, burrs, pick-up and fretting

R A. Ease high spots and remove burrs and pick-up, including
R pick-up on threads by stoning and/or light hand polishing.

R 3. Repair of pitting, stripping and rubbing marks

R A. Relieve pitting by blending, stoning and/or light hand
R polishing.

R 4. Repair of distortion and dents

R A. Remove distortion and dents by planishing and test for
R crack indications as detailed in the appropriate section.

R B. Remove distortion by blending/hand polishing.

R 5. Repair of nicks

R A. Blend, scallop and/or hand polish to obtain a smooth shape.

R 6. Repair of burned areas

R A. Dress, blend and polish to the standards detailed in
R 'Inspection'.

R 7. Repair of cracks

R A. Blend the affected area using a rotary file and hand
R polish.

R B. Blend, scallop and hand polish to the standards detailed
R in 'Inspection'.

R 8. Repair of battering

R A. Blend edges of battering marks to the general surface
R profile and hand polish.

R B. Scallop battering on the leading and trailing edges to a
R 5:1 length/depth minimum ratio and hand polish.

R C. Inspect after repair to the standards detailed in
R 'Inspection'.

LOCAL SURFACE PROTECTION

1. General

Whenever possible, damaged enamelled surfaces should be repaired by rubbing down with waterproof paper until the damaged area is blended smoothly with the surrounding surface and touched-up with air drying enamel.

2. Aluminium Cases

A. Material required:

	British Spec./Ref.	American Spec./Ref.	OMat Item No.
Air drying primer	CO.5151	-	708
Air drying enamel	CO.5153	-	7/35
Waterproof abrasive paper			
White spirit or	B.S.245	-	102
R Stoddard solvent	-	A.S.T.M. D484-52	102A

B. Remove corrosion from chipped areas by scraping, then blend area by rubbing down with waterproof abrasive paper.

C. Clean affected area thoroughly with white spirit. Allow fluid to evaporate completely.

D. Apply a coat of air drying primer and allow to dry for 2 hours.

E. Apply a coat of air drying enamel and allow to dry for at least 30 minutes.

3. Aluminium I.P. Compressor Cases

To repair areas of loss or damage to anodising on I.P. compressor casing, use aluminium conversion coating to T.S.D.594, O.P.330 brushing method.

4. Magnesium Cases

A. Material required:

	British Spec./Ref.	American Spec./Ref.	OMat Item No.
Air drying clear enamel	D.T.D.900/4236 CO.5187	-	7/24
Air drying primer	CO.5151	-	708
Air drying enamel	CO.5153	-	7/35
Chromate touch-up	-	-	1/202
Alocrom	1200	-	175
Waterproof abrasive paper			
White spirit or	B.S.245	-	102
R Stoddard solvent	-	A.S.T.M D.484-52	102A

B. Remove corrosion from chipped areas by scraping, then blend area by rubbing down with waterproof abrasive paper.

C. Clean affected area thoroughly with white spirit. Allow
R fluid to evaporate completely.

R D. WARNING: WHEN USING CHROMATE TOUCH-UP SOLUTION, APPROVED
R GLOVES AND GOGGLES SHOULD BE WORN. IN THE EVENT
R OF CONTAMINATION OF THE SKIN OR EYES WASH THE
R SOLUTION OFF WITH CLEAN WATER.
Paint affected area with chromate touch-up solution until a brown film forms on the surface.

E. Wash area with clean water and wipe dry immediately.

F. Apply a coat of air drying clear enamel and allow to dry for 30 minutes.

G. Apply a coat of air drying primer and allow to dry for 2 hours.

H. Apply a coat of air drying enamel and allow to dry for at least 30 minutes.

5. Steel Cases

A. Material required:

		British Spec./Ref.	American Spec./Ref.	OMat Item No.
	Air drying enamel	E.3892 (PL.82)	-	7/22
	Waterproof abrasive paper			
	White spirit	B.S.245	-	102
	or			
R	Stoddard solvent	-	A.S.T.M. D484-52	102A

B. Remove corrosion from chipped areas by scraping, then blend area by rubbing down with waterproof abrasive paper.

C. Clean affected area thoroughly with white spirit. Allow fluid to evaporate completely.

D. Apply a coat of air drying enamel and allow to dry for at least 30 minutes.

6. Light Alloy Skins

A. Material required:

		British Spec./Ref.	American Spec./Ref.	OMat Item No.
R	Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane)	B.S.4487: 1969	Mil-T-81533A	1/21
	Cleaning solution	MC.58	-	176
	Air dry clear enamel	C05187	-	7/24

B. WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Clean affected area thoroughly with cleaning solution or inhibited 1.1.1. trichloroethane. Allow fluid to evaporate completely.

C. Apply a coat of clear enamel to affected area and allow to dry for 30 minutes.

D. Apply a second coat of clear enamel and allow to dry for 30 minutes before handling.

7. Application of High Heat Resisting Enamel

A. Material required:

		British Spec./Ref.	American Spec./Ref.	OMat Item No.
R	Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane)	B.S.4487: 1969	Mil-T-81533A	1/21
	Cleaning solution	MC.58	-	176
	Air drying high heat resistant enamel	E.3892 (PL.82)	-	7/22

B. WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Clean affected area thoroughly with cleaning solution or inhibited 1.1.1. trichloroethane, using a clean cloth. Allow fluid to evaporate completely.

C. Apply a coat of high heat resistant enamel and allow to dry for 30 minutes.

SCREW THREADS

REPAIR THREADED HOLES BY FITTING WIRETHREAD INSERTS

ERS.3002

This repair covers:

Repair damaged threads and damaged inserts by fitting new inserts.
Fit and repair inserts in light alloy materials.

NOTE: When any insert is damaged during assembly, a new insert can be fitted without effecting disassembly by modifying the removal and insertion tools as shown in fig.8 and 9.

Fit screw lock inserts only when specified in the Illustrated Parts Catalogue.

Unless instructed by a Rolls-Royce repair, do not fit wirethread inserts into major rotating parts, highly stressed areas, e.g. engine mounts, or areas which are directly exposed to the high temperature gas stream.

CR 1. Gearbox Wire Thread (Heli Coil) Insert Repair

CR A. General

CR (1) External gearbox mount pads have experienced
CR wire threaded hole damage beyond that of straight
CR Heli Coil replacement.

CR B. Repair

CR (1) This repair is to approve use of ''Twinserts'' for
CR this application. Refer to R.R. RB211 Overhaul
CR Manual, 72-63-00, TWA Repair-7 for detail procedure.

R 2. Effectivity

I.P.C. Fig./Item	Part No.
Parts incorporating tapped holes	See Parts Catalogue for part numbers

R 3. Repair status

This repair has been proved practically.

R 4. Instructions

A. Definition of inserts

Screw lock insert - one coil is deformed to provide a self-locking element

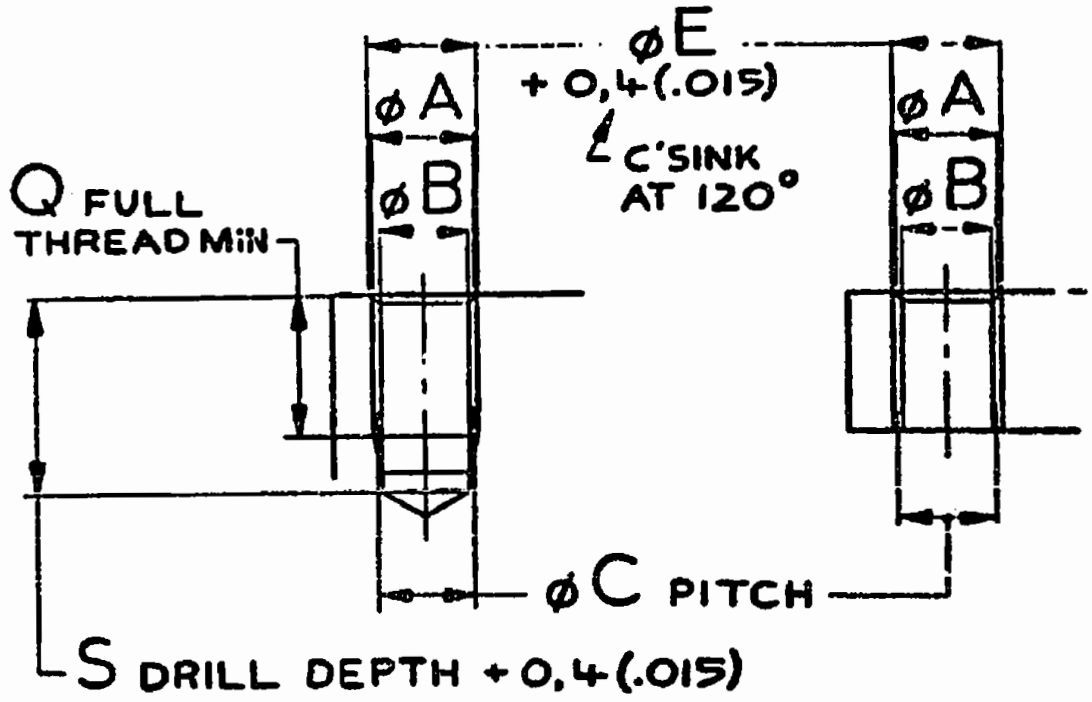
Free running insert - this has no self-locking element

Repair insert - a solid insert into which a wirethread insert is fitted.

B. Repair damaged threads by fitting inserts and replace damaged inserts

	Procedure	Supplementary information
(1)	Remove damaged insert or Machine hole for fitting insert	Tool: Item 1 See fig.5 Tools: Items 4 to 6 See figs.1 to 3
(2)	Clean and inspect hole	Tool: Item 7
(3)	Treat threads in magnesium with selenious acid	Refer to 70-42-12
(4)	Select correct insert	See '5. Parts'

Procedure	Supplementary Information
(5) Smear threads in magnesium and the corresponding insert with jointing compound	Jointing compound (OMat 426A)
(6) Fit insert	Tool: Item 2 See figs.1 and 6
(7) Remove tang	Tool: Item 3 See fig.7
(8) Crack test	
(9) Inspect	Tool: Item 8 or standard plug gauge See figs.1 and 4
(10) Check inbuilt torque of screw lock inserts	Tools: Items 9 to 11 See fig.11
(11) Vibro-engrave 'FRS.3002' adjacent to the part number except when replacing an existing insert	



Wirethread insert dimensions - Before and after fitting insert
Fig.1

Nominal unified thread size		No.4	No.6	No.8	No.10
Threads/in.		40	32	36	32
Diameter major 'A' (in.)		0.1445	0.1786	0.2001	0.2306
Diameter pitch 'C' (in.)		0.1299 0.1283	0.1601 0.1583	0.1840 0.1821	0.2123 0.2103
Diameter minor 'B' (in.)		0.1232 0.1142	0.1530 0.1450	0.1759 0.1709	0.2028 0.1978
Countersink diameter 'E'		3,94 (0.155)	4,83 (0.190)	5,48 (0.215)	6,1 (0.240)
Nominal length of 1D insert	Q	3,43 (0.135)	4,32 (0.170)	4,83 (0.190)	5,59 (0.220)
	S	6,35 (0.250)	7,87 (0.310)	8,13 (0.320)	9,14 (0.360)
Nominal length of $1\frac{1}{2}$D insert	Q	4,83 (0.190)	6,1 (0.240)	6,98 (0.275)	8,13 (0.320)
	S	7,75 (0.305)	9,65 (0.380)	10.16 (0.100)	11,68 (0.460)
Nominal length of 2D insert	Q	6,35 (0.250)	7,87 (0.310)	9,14 (0.360)	10,41 (0.410)
	S	9,27 (0.365)	11,43 (0.450)	12,19 (0.480)	13,97 (0.550)
Nominal length of $2\frac{1}{2}$D insert	Q	7,75 (0.305)	9,52 (0.375)	11,18 (0.440)	12,95 (0.510)
	S	10,67 (0.420)	13,08 (0.515)	14,22 (0.560)	16,51 (0.650)

D = Nominal thread diameter
Refer to fig.1 for Q and S
Dimensions in millimetres (conversions in inches) except where indicated

'Table continued on page 6'

31108

Threaded hole dimensions for wirethread inserts - Sheet 1
Fig.2

Nominal unified thread size (in.)		0.250	0.3125	0.375	0.4375	0.500
Threads (in.)		28	24	24	20	20
Diameter major 'A' (in.)		0.2964	0.3666	0.4291	0.5025	0.5650
Diameter pitch 'C' (in.)		0.2754 0.2732	0.3421 0.3395	0.4047 0.4020	0.4731 0.4700	0.5337 0.5325
Diameter minor 'B' (in.)		0.2639 0.2559	0.3278 0.3228	0.3899 0.3839	0.4561 0.4491	0.5176 0.5116
Countersink diameter 'E'		7,92 (0.312)	9,52 (0.375)	11,1 (0.437)	12,95 (0.510)	14,48 (0.570)
Nominal length of 1D insert	Q	7,37 (0.290)	8,89 (0.350)	10,67 (0.420)	12,45 (0.490)	13,97 (0.550)
	S	11,43 (0.450)	13,72 (0.540)	15,49 (0.610)	18,03 (0.710)	19,68 (0.775)
Nominal length of $1^1/2D$ insert	Q	10,41 (0.410)	12,95 (0.510)	15,24 (0.600)	18,03 (0.710)	20,32 (0.800)
	S	14,48 (0.570)	17,78 (0.700)	20,07 (0.790)	23,62 (0.930)	26,04 (1.025)
Nominal length of 2D insert	Q	13,72 (0.540)	17,02 (0.670)	20,07 (0.790)	23,62 (0.930)	26,67 (1.050)
	S	17,78 (0.700)	21,84 (0.860)	24,89 (0.980)	29,21 (1.150)	32,28 (1.275)
Nominal length of $2^1/2D$ insert	Q	16,76 (0.660)	20,83 (0.820)	24,89 (0.980)	29,08 (1.145)	33,02 (1.300)
	S	20,83 (0.820)	25,65 (1.010)	29,72 (1.170)	34,67 (1.365)	38,74 (1.525)

D = Nominal thread diameter
Refer to fig.1 for Q and S
Dimensions in millimetres (conversions in inches) except where indicated

31109

Threaded hole dimensions for wirethread inserts – Sheet 2
Fig.3

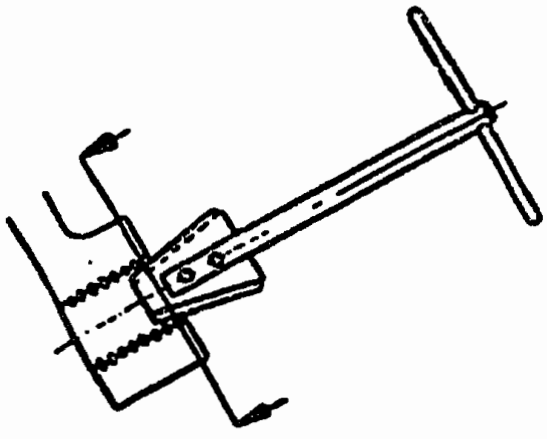
Nominal unified thread size		No.4	No.6	No.8	No.10
Threads/in.		40	32	36	32
Minimum minor diameter 'G' (in.)		0.0849	0.1042	0.1339	0.1562
Pitch diameter 'H' (in.)		0.0982 0.0958	0.1204 0.1177	0.1487 0.1460	0.1726 0.1697
Minimum length of assembled insert 'K'	1D	2,36 (0.093)	2,9 (0.114)	3,63 (0.143)	4,24 (0.167)
	$1^1/2D$	3,78 (0.149)	4,65 (0.183)	5,72 (0.225)	6,65 (0.262)
	2D	5,21 (0.205)	6,4 (0.252)	7,8 (0.307)	9,07 (0.357)
	$2^1/2D$	6,63 (0.261)	8,15 (0.321)	9,88 (0.389)	11,48 (0.452)

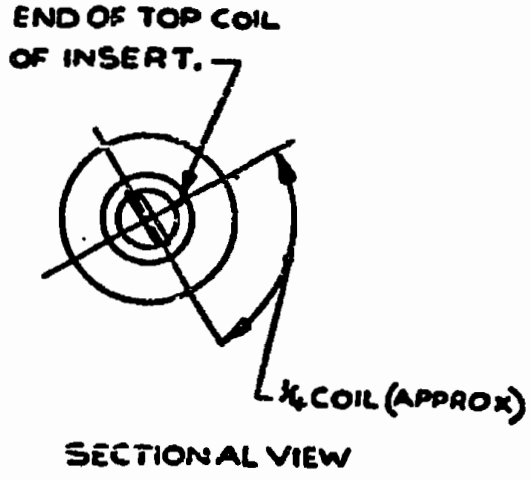
Nominal unified thread size (in.)		0.250	0.3125	0.375	0.4375	0.500
Threads/in.		28	24	24	20	20
Minimum minor diameter 'G' (in.)		0.2113	0.2674	0.3299	0.3834	0.4459
Pitch diameter 'H' (in.)		0.2300 0.2268	0.2890 0.2854	0.3516 0.3479	0.4091 0.4050	0.4717 0.4675
Minimum length of assembled inserts 'K'	1D	5,66 (0.223)	7,14 (0.281)	8,74 (0.344)	10,16 (0.400)	11,73 (0.462)
	$1^1/2D$	8,84 (0.348)	11,13 (0.438)	13,49 (0.531)	15,72 (0.619)	18,08 (0.712)
	2D	12,01 (0.473)	15,09 (0.594)	18,26 (0.719)	21,29 (0.838)	24,43 (0.962)
	$2^1/2D$	15,19 (0.598)	19,05 (0.750)	23,01 (0.906)	26,82 (1.056)	30,78 (1.212)

D = Nominal thread diameter
Refer to fig.1 for G and H
Dimensions in millimetres (conversions in inches) except where indicated

31110

Dimensions of assembled inserts
Fig.4



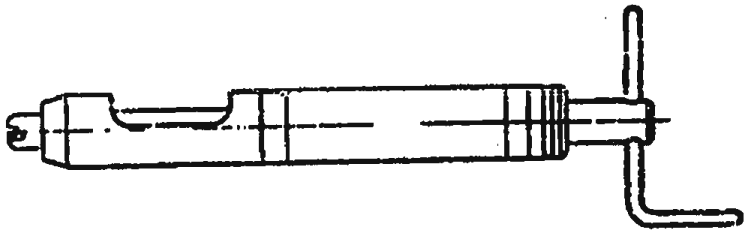


SECTIONAL VIEW

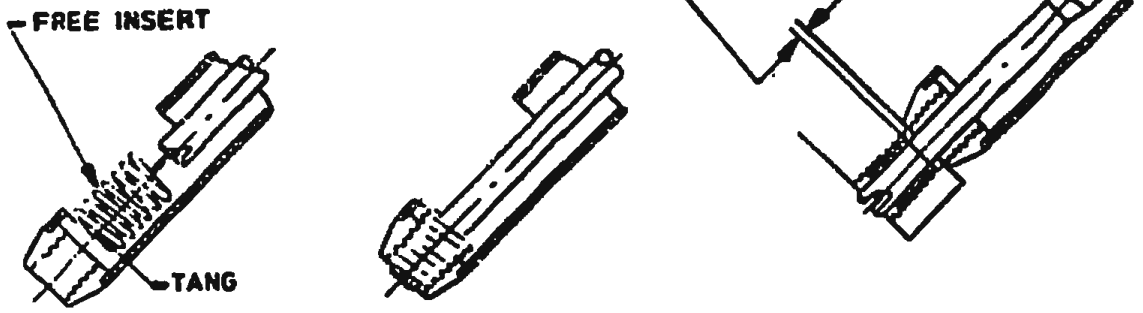
PRESS SPECIAL TOOL INTO INSERT AT APPROX. 1/4 OF A COIL FROM THE END OF THE INSERT WIRE. ROTATE ANTI-CLOCKWISE TO WIND INSERT OUT. DISCARD INSERT.

30918

Remove existing insert
Fig.5



PLAIN TYPE INSERTION TOOL-
FREE RUNNING INSERTS



DRAW BACK MANDREL AND PLACE INSERT IN CHAMBER WITH TANG AT NOZZLE END.

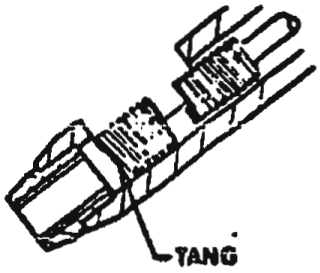
ENGAGE TANG IN SLOT OF MANDREL, ROTATE MANDREL CLOCKWISE AND PUSH FORWARD GENTLY UNTIL INSERT ENGAGES IN NOZZLE, WIND MANDREL UNTIL INSERT JUST EMERGES.

PLACE TOOL SQUARELY OVER TAPPED HOLE. WIND MANDREL UNTIL INSERT IS CORRECTLY IN POSITION. NO FORWARD PRESSURE SHOULD BE USED.

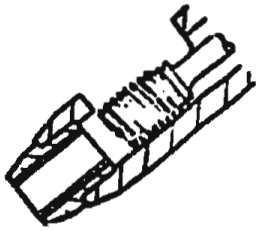
30919

Installation procedure
Fig.6

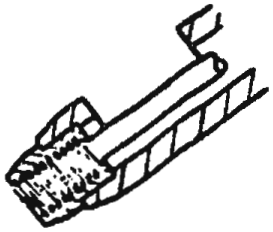
PRE-WIND TYPE INSERTING TOOL - FREE RUNNING AND SCREW LOCK INSERTS



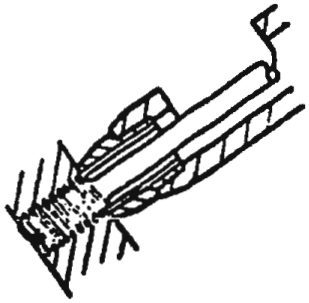
WITHDRAW THE THREADED MANDREL AND PLACE THE INSERT IN THE LOADING CHAMBER.



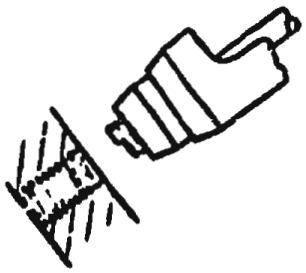
PREVENT THE INSERT FROM MOVING WITH THE THUMB AND ROTATE THE THREADED MANDREL CLOCKWISE UNTIL THE DRIVING FEATURE ENGAGES THE INSERT TANG.



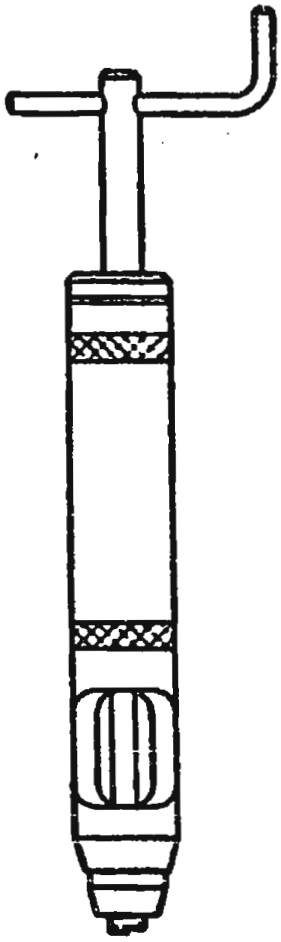
ROTATE THE MANDREL CLOCKWISE AND PUSH FORWARD GENTLY UNTIL THE INSERT LOCATES THE THREAD IN THE TOOL NOZZLE. CONTINUE WINDING THE INSERT INTO THE NOZZLE UNTIL THE INSERT IS ABOUT TO EMERGE FROM THE OPEN END.



PLACE THE LOADED TOOL SQUARELY OVER THE TAPPED HOLE IN THE COMPONENT WHICH IS TO RECEIVE THE INSERT AND ROTATE THE MANDREL CLOCKWISE UNTIL THE INSERT IS AT THE REQUIRED DEPTH.



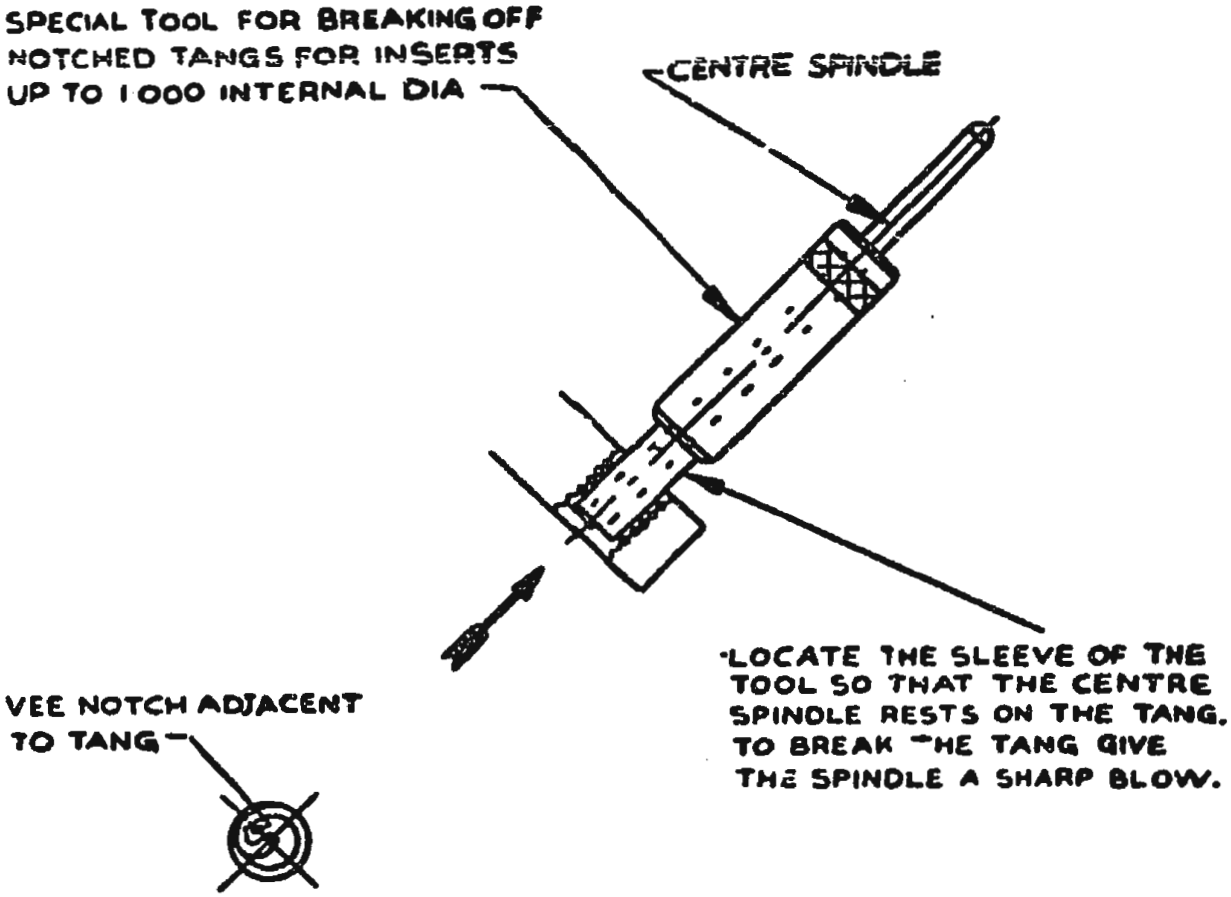
ROTATE THE MANDREL ANTI-CLOCKWISE UNTIL IT IS CLEAR OF THE INSERT.



INSERTING TOOL PREWINDING TYPE (THREADED MANDREL)

30920

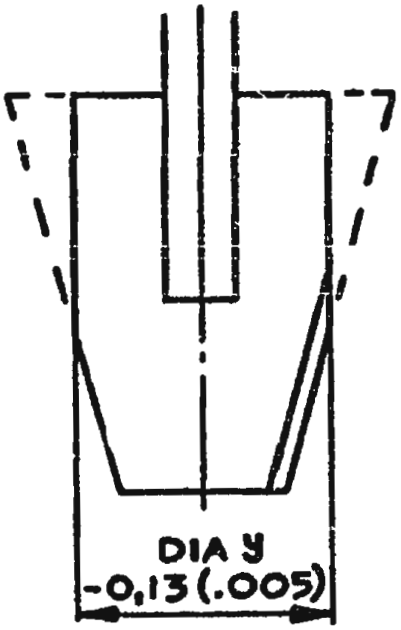
Installation procedure
Fig.6A


SPECIAL TOOL FOR BREAKING OFF NOTCHED TANGS FOR INSERTS UP TO 1000 INTERNAL DIA
CENTRE SPINDLE
LOCATE THE SLEEVE OF THE TOOL SO THAT THE CENTRE SPINDLE RESTS ON THE TANG. TO BREAK THE TANG GIVE THE SPINDLE A SHARP BLOW.
VEE NOTCH ADJACENT TO TANG
VIEW ON ARROW

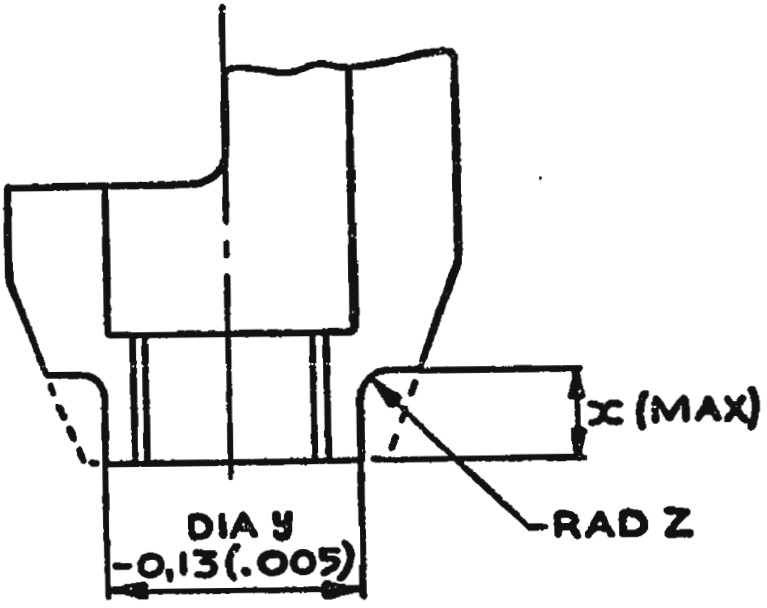
FOR LARGER INSERTS USE SMALL PLIERS AND BEND THE TANG UP AND DOWN, NOT SIDEWAYS.

30921

Remove insert tang
Fig.7



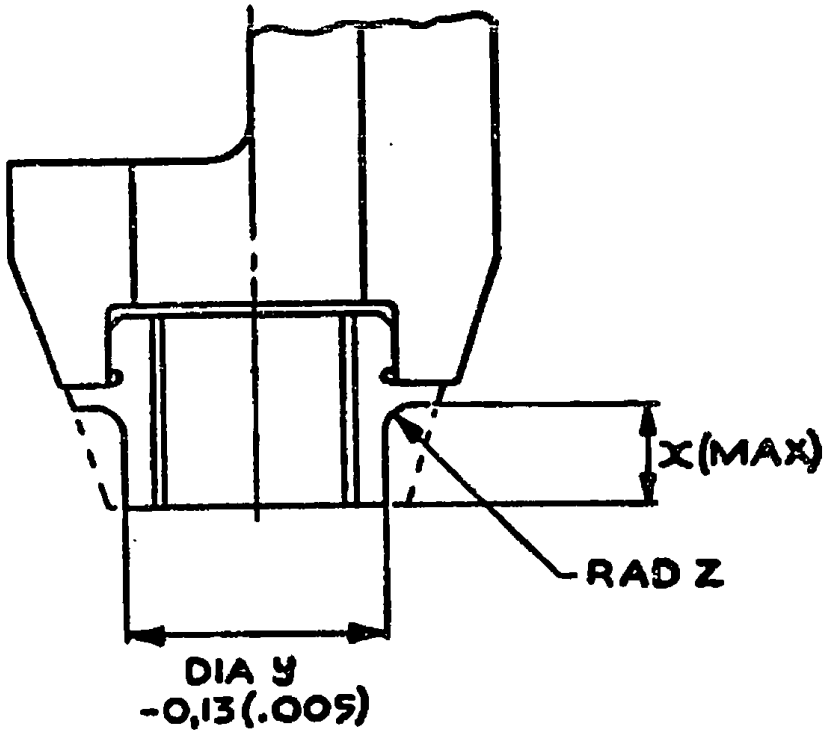
a) EXTRACTION TOOL.



b) NYLON INSERTION TOOL

30922

Modify tools to fit wirethread inserts assembled parts - Sheet 1
Fig.8



c) ALUM. BODY AND STEEL NOZZLE

30923

Modify tools to fit wirethread inserts
assembled parts - Sheet 2
Fig.9

Nominal unified thread size	No.4	No.6	No.8	No.10
Threads/in	40	32	36	32
Dimension 'X'	4,57 (0.180)	4,57 (0.180)	4,57 (0.180)	5,84 (0.230)
Diameter 'y'	4,44 (0.175)	5,33 (0.210)	5,97 (0.235)	6,6 (0.260)
Radius 'z'	1,27 (0.050)	1,27 (0.050)	1,27 (0.050)	1,27 (0.050)

Nominal unified thread size (in.)	0.250	0.3125	0.375	0.4375	0.500
Threads/in.	28	24	24	20	20
Dimension 'X'	5,84 (0,230)	5,84 (0 230)	5,84 (0.230)	5,84 (0.230)	5,84 (0.230)
Diameter 'y'	8,26 (0.325)	10,03 (0.395)	11,68 (0.460)	13,46 (0.530)	15,11 (0.595)
Radius 'z'	1,27 (0.050)	1,27 (0.050)	1,27 (0.050)	1,27 (0.050)	1,27 (0.050)

y - Minimum diameter for insertion through panels (figs.8 and 9)
Dimensions in millimetres (conversions in inches)

31111

Tool dimensions to fit wirethread inserts in assembled parts
Fig.10

Nominal unified thread size	Threads/in.	Minimum		Maximum	
		lb.in.	Nm.	lb.in.	Nm.
No.4	40	2.5	0,056	3	0,339
No.5	32	1.0	0,113	6	0,678
No.8	36	1.5	0,169	9	1,017
No.10	32	2.0	0,226	18	2,034
0.250in.	28	3.5	0,282	30	3,39
0.3125in.	24	6.5	0,734	60	6,78
0.375in.	24	9.5	1,017	80	9,04
0.4375in.	20	14.0	1,582	100	11,3
0.500in.	20	18.0	2,034	150	16,95

Select minimum torque check plug, torque adapter and Torquemaster.

Lubricate minimum torque check plug with engine oil and fit into insert, engage torque adapter and using a standard key spanner, check for insert screw-through by spannering torque check plug through grip coil to full depth of the insert. Reject insert if it has turned more than half a thread in part.

Unscrew torque check plug sufficient to clear locking coil and remove key spanner. Set Torquemaster to correct poundage detailed above and check in-built torque using Torquemaster. Reject insert if torque check plug screws through grip coil.

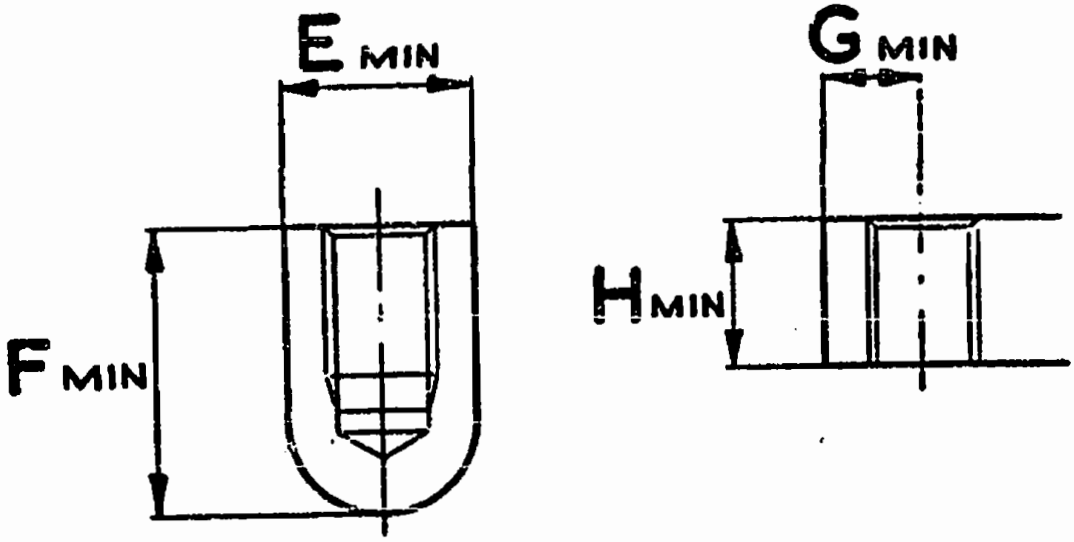
Inserts below minimum torque must be removed and a new insert fitted.

31112

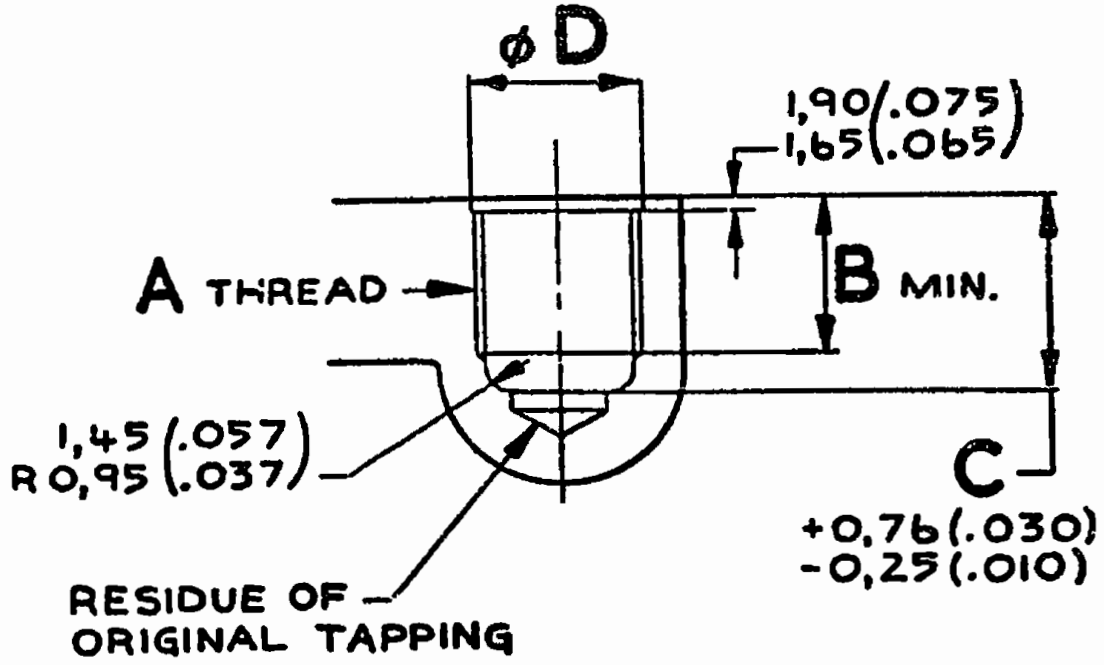
Inbuilt torque of screw lock inserts
Fig.11

C. Fit repair inserts

Procedure	Supplementary information
(1) Dimensionally inspect part	See figs.12 to 14. Ensure that boss proportions are adequate
(2) Machine hole	Tool: See '4. Tools' See figs.12 and 15
(3) Clean and inspect	Tool: Standard plug gauge See figs.12 and 15
(4) Treat threads in magnesium with selenious acid	Refer to 70-42-12
(5) Select correct insert	See '5. Parts'
(6) Smear threads in magnesium and the corresponding insert with jointing compound	OMat 426A
(7) Fit repair insert	Tool: Item 15 See fig.17
(8) Inspect	See fig.17
(9) Fit wirethread insert	See 3.B
(10) Vibro-engrave 'FRS.3002' adjacent to the part number	



MINIMUM DIMENSIONS FOR USE OF REPAIR INSERTS IN LIGHT ALLOY



DETAILS OF TAPPED HOLES FOR REPAIR INSERTS

30924

Dimension standards for inserts in light alloy materials - Sheet 1
Fig.12

BOSS PROPORTIONS - LIGHT ALLOY - PROVISION FOR REPAIR					
Nominal diameter insert		No.10	0.250 in.	0.3125 in.	0.375 in.
Threads/in.		32	28	24	24
Nominal insert length 1D	'E'	13,97 (0.550)	15,51 (0.650)	19,05 (0.750)	21,59 (0.850)
	'F'	13,72 (0.540)	17,02 (0.670)	20,07 (0.790)	22,86 (0.900)
	'G'	6,98 (0.275)	8,26 (0.325)	9,52 (0.375)	10,8 (0.425)
	'H'	6,35 (0.250)	7,62 (0.300)	9,14 (0.360)	10,8 (0.425)
Nominal insert length 1 1/2D	'E'	13,97 (0.550)	16,51 (0.650)	19,05 (0.750)	21,59 (0.850)
	'F'	16,26 (0.640)	20,07 (0.790)	24,13 (0.950)	27,43 (1.080)
	'G'	6,98 (0.275)	8,26 (0.325)	9,52 (0.375)	10,8 (0.425)
	'H'	9,78 (0.385)	11,05 (0.435)	13,21 (0.520)	15,49 (0.610)

D = Nominal thread diameter
Dimensions in millimetres (conversions in inches) except where indicated

31113

Dimension standards for inserts in light alloy materials - Sheet 2
Fig.13

BOSS PROPORTIONS - LIGHT ALLOY - PROVISION FOR REPAIR					
Nominal diameter insert		No.10	0.250 in.	0.3125 in.	0.375 in.
Threads/in.		32	28	24	24
Nominal insert length 2D	'E'	13,97 (0.550)	16,51 (0.650)	19,05 (0.750)	21,59 (0.850)
	'F'	18,54 (0.730)	23,37 (0.920)	28,19 (1.110)	32,26 (1.270)
	'G'	6,98 (0.275)	8,26 (0.325)	9,52 (0.375)	10,8 (0.425)
	'H'	11,43 (0.450)	13,97 (0.550)	17,27 (0.680)	20,32 (0.800)
Nominal insert length $2^1/2D$	'E'	13,97 (0.550)	16,51 (0.650)	19,05 (0.750)	21,59 (0.850)
	'F'	21,08 (0.830)	26,42 (1.040)	32,0 (1.260)	37,08 (1.460)
	'G'	6,98 (0.275)	8,26 (0.325)	9,52 (0.375)	10,8 (0.425)
	'H'	13,21 (0.530)	17,02 (0.670)	21,08 (0.830)	25,15 (0.990)

D = Nominal thread diameter
Dimensions in millimetres (conversions in inches) except where indicated

31114

Dimension standards for inserts in light alloy materials - Sheet 3
Fig.14

DIMENSIONS OF TAPPED HOLES FOR REPAIR INSERTS (LIGHT ALLOY)					
Special unified thread form 'A'	Wirethread insert		B	C	D (in.)
	Size	Length			
0.3105in. diameter 24 thread/in. (Light alloy) Minor diameter 0.2812in. to 0.2862in.	No.10 32 threads/in.	1D	8.13 (0.320)	10,67 (0.420)	0.3348 0.3218
		1 1/2D	9,78 (0.385)	12,32 (0.485)	
		2D	11,43 (0.450)	13,97 (0.550)	
		2 1/2D	13,21 (0.520)	15,75 (0.620)	
0.4355in. diameter 20 threads/in. (Light alloy) Minor diameter 0.3888in. to 0.3970in.	6,35 (0.250in.) 28 threads/in.	1D	9,14 (0.360)	11,68 (0.460)	0.4681 0.4481
		1 1/2D	11,05 (0.435)	13,59 (0.535)	
		2D	12,95 (0.510)	15,49 (0.610)	
		2 1/2D	16,0 (0.630)	18,54 (0.730)	

D = Nominal thread diameter
Dimensions in millimetres (conversions in inches) except where indicated

31115

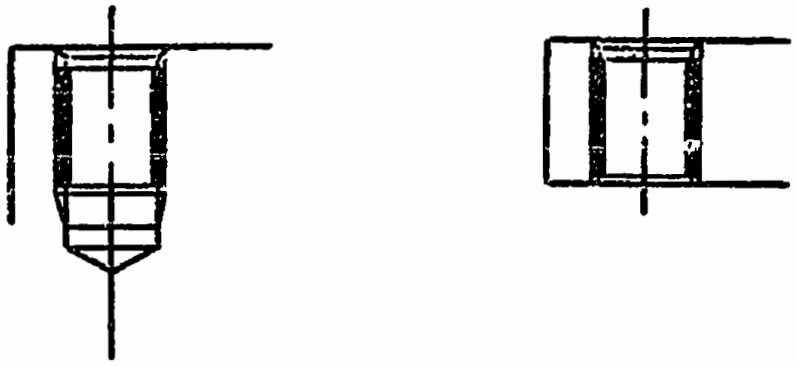
Dimension standards for inserts in light alloy materials - Sheet 4
Fig.15

DIMENSIONS OF TAPPED HOLES FOR REPAIR INSERTS (LIGHT ALLOY)					
Special unified thread form 'A'	Wirethread insert		B	C	D (in.)
	Size	Length			
0.4975in. diameter, 20 threads/in. (Light alloy) Minor diameter 0.4513in. to 0.4597in.	0.3125in. 24 threads/in.	1D	10,29 (0.405)	12,83 (0.505)	0.5306 0.5106
		1 1/2D	12,83 (0.505)	15,37 (0.605)	
		2D	16,26 (0.640)	18,8 (0.740)	
		2 1/2D	20,32 (0.800)	22,86 (0.900)	
0.5600in. diameter, 18 threads/in. (Light alloy) Minor diameter 0.5084in. to 0.5172in.	0.375in. 24 threads/in.	1D	12,06 (0.475)	14,6 (0.575)	
		1 1/2D	15,49 (0.610)	18,03 (0.710)	0.5931 0.5731
		2D	19,56 (0.770)	22,1 (0.870)	
		2 1/2D	24,38 (0.960)	26,82 (1.060)	

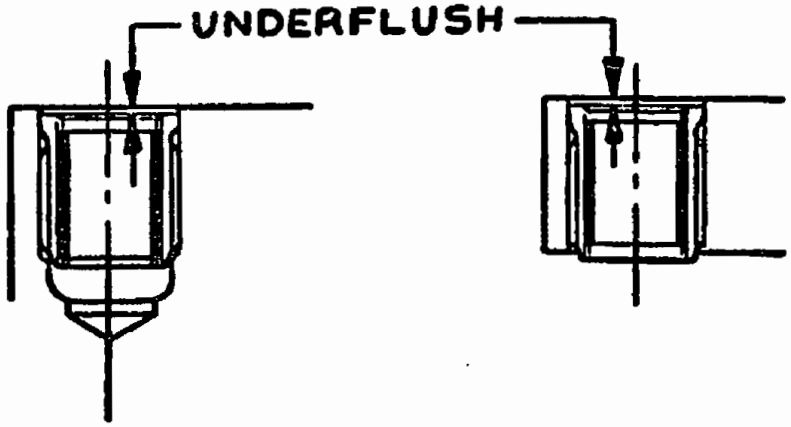
D = Nominal thread diameter
Dimensions in millimetres (conversions in inches) except where indicated

31116

Dimension standards for inserts in light alloy materials - Sheet 5
Fig.16



BEFORE REPAIR



AFTER REPAIR

30926

Repair inserts - Before and after repair
Fig.17

WIRETHREAD INSERTS					
Nominal unified thread size	No.4	No.6	No.8	No.10	Item No.
Threads/in.	40	32	36	32	
Extraction tool	HC.22912	HC.22912	HC.22912	HC.22913	1
Inserting tool (pre-wind type)	1709101	1709103	3405506	HC.22891	2
Tang removal tool	1709121	1709123	3405526	3405527	3
Roughing tap	1709721	1709723	1709502	1709503	4
Plug tap	1709741	1709743	1709522	1709523	5
Bottoming tap	1709761	1709763	1709542	1709543	6
Special gauge for tapped hole	1709581	1709583	1709562	1709563	7
Cross thread gauge	-	-	HCU.5035	HCU.5036	8
Torque check plug	HC.7943	HC.7941	HC.7942	HC.21739	9
Torque adapter	HC.21743	HC.21743	HC.21743	HC.21743	10
Torquemaster	R.R.1704302 (all thread sizes)				11
Torque setting rig	1702173	1702173	1702173	1702173	12

31117

WIRETHREAD INSERTS					
Nominal unified thread size	6,35 mm. (0.250in.)	7,92 mm. (0.3125in.)	9,52 mm. (0.375in.)	11,05 mm. (0.4375in.)	Item No.
Threads/in.	28	24	24	20	-
Extraction tool	HC.22914	HC.22914	HC.22915	1709083	1
Inserting tool (pre-wind type)	HC.22892	HC.22943	HC.25569	3405511	2
Tang removal tool	3405528	3405529	3405530	3405531	3
Roughing tap	1709504	1709505	1709506	1709507	4
Plug tap	1709524	1709525	1709526	1709527	5
Bottoming tap	1709544	1709545	1709546	1709547	6
Special gauge for tapped hole	1709564	1709565	1709566	1709567	7
Cross thread gauge	HCU.5037	HCU.5038	HCU.5039	HCU.5040	8
Torque check plug	HC.21740	HC.21741	HC.21742	HC.22844	9
Torque adapter	HC.21743	HC.21743	HC.21743	HC.21743	10
Torquemaster	R.R.1704302 (all thread sizes)				11
Torque setting rig	1702173	1702173	1702173	1702173	12

31118

WIRETHREAD INSERTS					
Nominal unified thread size	12,7 mm. (0.500in.)				Item No.
Thread/in.	20				-
Extraction tool	1709063				1
Inserting tool (pre-wind type)	3405512				2
Tang removal tool	3405532				3
Roughing tap	1709508				4
Plug tap	1709528				5
Bottoming tap	1709548				6
Special gauge for tapped hole	1709568				7
Cross thread gauge					8
Torque check plug	HC.22845				9
Torque adapter	HC.21743				10
Torquemaster	R.R.1704302 (all thread sizes)				11
Torque setting rig	1702173				12

31119

REPAIR INSERTS					
Insert unified size	No.10	0.250in.	0.3125in.	0.375in.	Item No.
Threads/in.	32	28	24	24	-
Special drill	HU.12680	HU.12681	HU.12682	HU.12683	9
Counterbore cutter	HU.15980	HU.15981	HU.15982	HU.15983	10
Tap	GU.11416	GU.11418	GU.11419	GU.11420	11
Insert driver	HU.12675	HU.12676	HU.12677	HU.12678	12
TOOLS FOR HAND CUTTING					
Pilot screw	HU.15963	HU.14808	HU.14829	HU.15971	13
Counterbore cutter	HU.15964	HU.15968	HU.14832	HU.15972	14
Counterbore stop	HU.15965	HU.15969	HU.15970	HU.15973	15
Hollow cutter	HU.15966	HU.14706	HU.14831	HU.15974	16
Radius cutter	HU.15967	HU.14798	HU.14830	HU.15975	17

31120

WIRETHREAD INSERTS				
Nominal unified thread size	Threads/in.	Length of insert	Rolls-Royce Part No.	
			*Screw lock type	*Free running type
No.4	40	1D	U.780200	U.140302
		1 1/2D	U.780201	U.140342
		2D	U.780202	U.140382
		2 1/2D	U.780203	U.140422
No.6	32	1D	U.780205	U.140303
		1 1/2D	U.780206	U.140343
		2D	U.780207	U.140383
		2 1/2D	U.780208	U.140423
No.8	36	1D	U.780215	U.140004
		1 1/2D	U.780216	U.140044
		2D	U.780217	U.140084
		2 1/2D	U.780218	U.140124
No.10	32	1D	AGS.3706	U.140005
		1 1/2D	AGS.3731	U.140045
		2D	AGS.3756	U.140085
		2 1/2D	AGS.3781	U.140125

D = Nominal diameter of insert

* = The part numbers in these columns are not alternatives

31121

WIRETHREAD INSERTS				
Nominal unified thread size	Threads/in.	Length of insert	Rolls-Royce Part No.	
			*Screw lock type	*Free running type
0.250in.	28	1D	AGS.3707	U.140006
		1 1/2D	AGS.3732	U.140046
		2D	AGS.3757	U.140086
		2 1/2D	AGS.3782	U.140126
0.3125in.	24	1D	AGS.3708	U.140007
		1 1/2D	AGS.3733	U.140047
		2D	AGS.3758	U.140087
		2 1/2D	AGS.3783	U.140127
0.375in.	24	1D	AGS.3709	U.140008
		1 1/2D	AGS.3734	U.140048
		2D	AGS.3759	U.140088
		2 1/2D	AGS.3784	U.140128
0.4375in.	20	1D	AGS.3710	U.140009
		1 1/2D	AGS.3735	U.140049
		2D	AGS.3760	U.140089
		2 1/2D	AGS.3785	U.140129
0.500in.	20	1D	AGS.3711	U.140010
		1 1/2D	AGS.3736	U.140050
		2D	AGS.3761	U.140090
		2 1/2D	AGS.3786	U.140130

D = Nominal diameter of insert

* = The part numbers in these columns are not alternatives 31122

REPAIR INSERTS			
Wirethread insert unified size	Threads/in.	Length of insert	Rolls-Royce Part No.
No.10	32	1D	KU.37016
		1 1/2D	KU.37017
		2D	KU.37018
		2 1/2D	KU.37019
(0.250in.)	28	1D	KU.37021
		1 1/2D	KU.37022
		2D	KU.37023
		2 1/2D	KU.37024
(0.3125in.)	24	1D	KU.37026
		1 1/2D	KU.37027
		2D	KU.37028
		2 1/2D	KU.37029
(0.375in.)	24	1D	KU.37031
		1 1/2D	KU.37032
		2D	KU.37033
		2 1/2D	KU.37034

D = Nominal diameter of insert

31123

CAPTIVE NUTS

REPLACEMENT OF DAMAGED OR LOOSE CAPTIVE NUTS

FRS.3035

1. Effectivity

I.P.C. Fig./Item	Part No.
All captive nuts	See Parts Catalogue for part numbers

2. Repair status

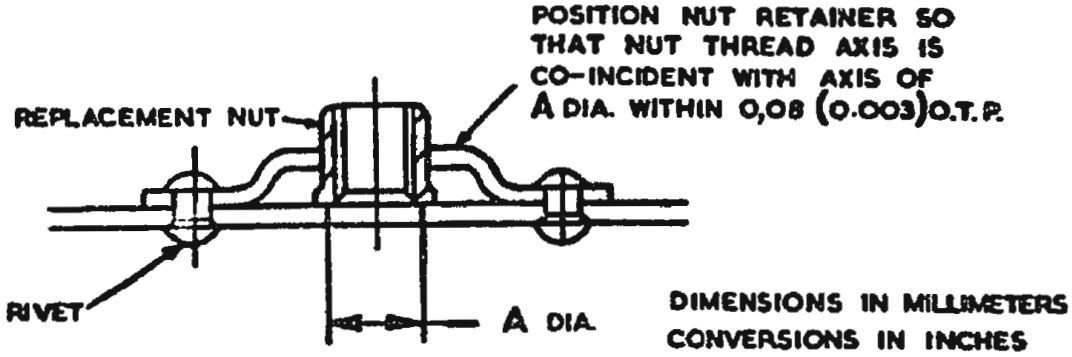
This repair has been proved practically.

3. Instructions

A. Remove captive nuts and fit replacement nuts.

Procedure	Supplementary information
(1) Remove rivets	Tool: Hand grinder Avoid thinning component
(2) Secure nut	Tool: Bolt
(3) Clamp retaining plate in position	
(4) Drill holes in retaining plate coincident with holes in component, if necessary	
(5) Drill holes oversize for oversize rivets, if necessary	
(6) Fit rivets	

RIVET HEADS ARE ROUND OR COUNTERSUNK ACCORDING TO POSITION


POSITION NUT RETAINER SO THAT NUT THREAD AXIS IS CO-INCIDENT WITH AXIS OF A DIA. WITHIN 0,08 (0.003) O.T.P.
REPLACEMENT NUT
RIVET
A DIA.
DIMENSIONS IN MILLIMETERS
CONVERSIONS IN INCHES

30908

Typical section through captive nut and retaining plate
Fig.1

Procedure	Supplementary information
(7) Remove retaining bolt and check nut position	See fig.1
(8) Crack test	

4. Tools

Special tools are not required.

5. Parts

A. Parts required

I.P.C. Fig./Item	Part No.
Captive nuts	See Parts Catalogue for part numbers

6. Price and Availability

Engine parts) Refer to Rolls-Royce
Repair of spares)

ACCEPTABLE CRACKS - STOP DRILLING

FRS.3255

1. General

This scheme covers drilling of crack stopper holes, to prevent further propagation of acceptable cracks.

It should only be used where called up in the relevant inspection chapters.

2. Instructions

A. Operations

(1) Dye penetrant crack test to determine crack within acceptance limit.

R (2) Stop drill with an 1,59 mm. (0.062in.) drill and deburr.

(3) Crack test (dye penetrant) to ensure crack is correctly stop drilled.

(4) Vibro-engrave 'FRS.3255' adjacent to part number.

R # CONNECTION OF ELECTRICAL PLUGS

R 1. General

R Incorrect connection of electrical plugs may result in ingression of moisture into the plugs and mating receptacles causing spurious electrical signals or failure of the affected circuits. Adherence to the following instructions will prevent such occurences.

R Material Required:

	British Spec./Ref.	American Spec./Ref.	OMat Item No.
R Cleaning fluid Isopropanol (Isopropanol alcohol)	'Analar' grade	-	1/119
R Disposable Cleaning tissues	Kim wipe (No.3435)	-	2/67
R Lockwire	DTD 189A 22 S.W.G.	21 S.W.G.	238

R 2. Pyle-National

R A. Prepare for Connection

R (1) Remove protective caps from plug and associated receptacle; retain caps in clean, dry bag.

R (2) Inspect plug and receptacle for liquid/solid contamination. Clean as necessary, using cleaning fluid, observing the following instructions:

R WARNING: WHEN USING CLEANING FLUID ENSURE ADEQUATE VENTILATION, AVOID SKIN CONTACT AND INHALING THE VAPOUR.

R (a) Clean contaminated surfaces by brush or spray application.

R NOTE: Do not spray or use compressed air at a pressure exceeding 15 p.s.i.

R (b) If plug or receptacle is positioned such that excess fluid cannot escape, use lint-free cloth or tissues to absorb fluid. Alternatively, use compressed air to disperse fluid.

R (c) Dry cleaned surfaces using clean, dry air.

R (3) Harness Mounted Plugs and Receptacles

R (a) Inspect for damaged/corroded parts; swollen, oil-soaked and damaged inserts. Repair or renew as applicable (ref. WDM 20-21-00 Assembly and maintenance of electrical connectors).

R (4) Unit Mounted Receptacles

R (a) Inspect for damaged/corroded parts; swollen, oil soaked and damaged inserts. Repair or renew as applicable (ref. relevant Vendor's Overhaul Manual).

R B. Connection of Plug

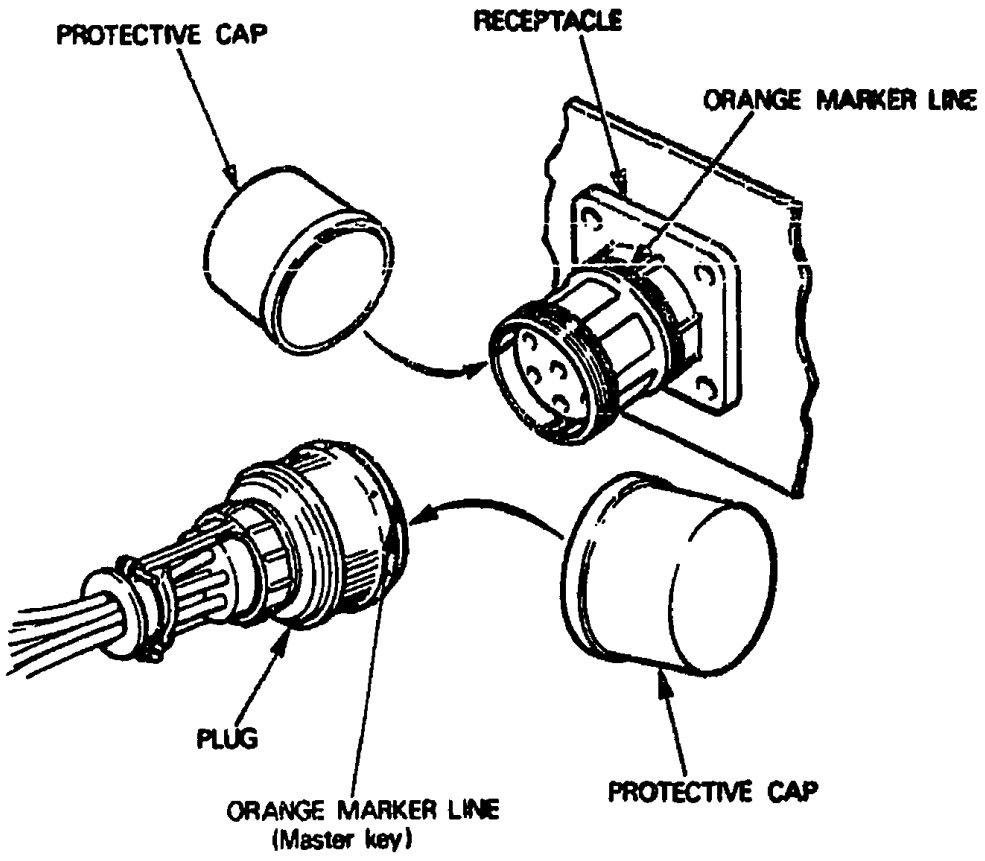
R (1) Refer to Fig.1, align orange master key marker line on plug with receptacle master key.

R (2) Engage plug into receptacle using light hand pressure.

R CAUTION: THE ORANGE MARKER LINE ON THE RECEPTACLE IS NOT A STOP LINE. THE LINE MUST BE COMPLETELY OBSCURED BY THE LEADING EDGE OF THE KNURLED NUT OF THE PLUG.

R (3) Screw knurled nut of the plug clockwise onto thread of receptacle ensuring correct engagement of threads. Continue rotating nut until orange marker line on receptacle is completely obscured and first audible click of nut is heard. Screw for further one-quarter to one-third turn then stop.

R (4) Wirelock as applicable, using locking wire.



Pyle-National Plug and Receptacle
Fig.1

3. Matrix Connector

A. Prepare for connection as instructed for Pyle National, Ref. para.2.A.

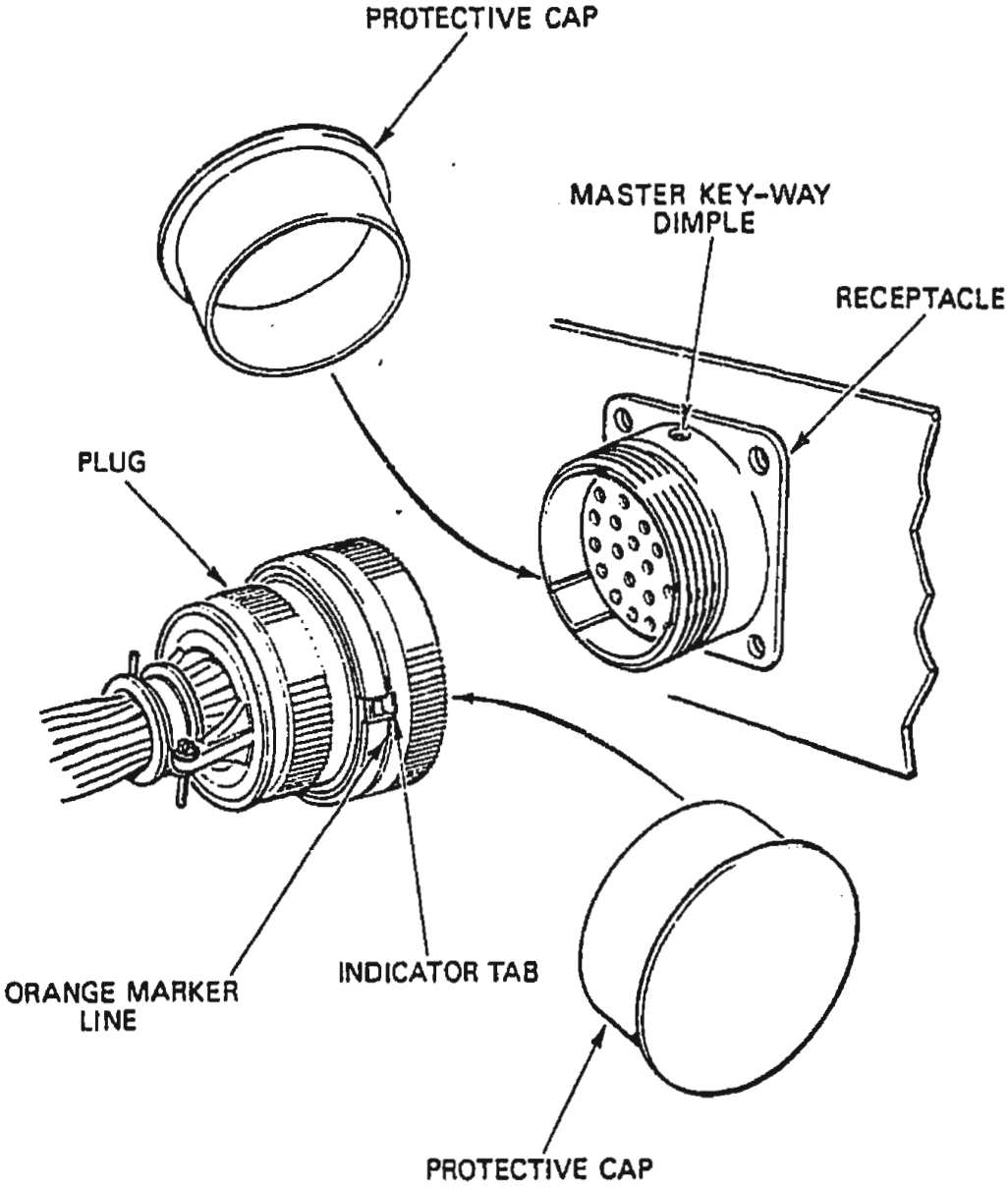
B. Connection of Plug

(1) Align plug master key with receptacle master keyway

(2) Engage plug into receptacle using light hand pressure

(3) Screw knurled nut of plug clockwise onto thread of receptacle ensuring correct engagement of threads. Continue rotating nut and tighten to firm hand pressure. For full and complete engagement, check that the indicator tab in the cutaway portion of the knurled ring is in line with the orange indicator line.

R CAUTION: THE BLUE MARKER LINES ON THE RECEPTACLE ARE
R FOR IDENTIFICATION PURPOSES ONLY, THE LINES
R DO NOT INDICATE CORRECT CONNECTION.



Matrix Plug and Receptacle
Fig.2

TORQUE TIGHTENING TECHNIQUE

1. General

R A. A predetermined torque load is applied to nuts, bolts and setscrews to prevent overstressing and to provide optimum security. During assembling of the parts and assembling of the complete engine, nuts, bolts and setscrews must be tightened to either a special load for a particular application or to a standard load for the size of screw thread used. The parts to be torque tightened to special loads are listed in the relevant Fits, Clearances and Torque Loading schedule. Tables of standard torque loads are in this Standard Practice. Parts for which no special load is specified in the relevant Fits, Clearances and Torque Loading schedule should be tightened to the standard loads listed in the tables. The assembly of face-tooth joints is given in para.18.

R 2. R Lubrication

R A. Lubrication is of great importance in achieving the correct tension in a threaded assembly because most of the applied torque is absorbed by friction at the screw thread and on the mating faces of the parts.

R B. The standard lubricant to be used is clean engine oil, i.e. any of the approved oils used for the engines lubrication system, or graphite-base lubricant PL.198 (OMat Item 4/20) which should be applied to the bolt threads and nut abutment faces.

R C. PL.198 is the only lubricant, as an alternative to engine
R oil, which is approved for general use on threaded parts.
R The use of any other lubricants, including solid film
R lubricants in any form or any containing molybdenum
R disulphide is prohibited unless specifically instructed.

R D. When a special lubricant is required, e.g. for extremely
R high torque loading or high temperature operating zones
R of the engine, the correct lubricant will be specified
R in the relevant Chapter/Section in Fits, Clearances and
R Torque Loading or Assembly.

R E. The mean tensile load induced by the same applied torque
R can be as much as 80 per cent greater using an incorrect
R lubricant; bolts can be severely overstressed to the
R point of constant torquing.

3. Retightening of nuts

R CAUTION: FAILURE TO CARRY OUT THE FOLLOWING INSTRUCTION COULD
R RESULT EITHER IN AN INADEQUATE CLAMPING LOAD OR, IF
R THE CORRECT TORQUE LOAD IS EXCEEDED IN AN ATTEMPT TO
R INCREASE THE CLAMPING LOAD, IN DAMAGE TO THE THREADS.
R THIS MAY NOT BE OBVIOUS AT THE TIME BUT MAY CAUSE
R FAILURE OF THE JOINT DURING SERVICE.

R A. Whenever it becomes necessary to retighten nuts, remove the
R nuts, clean and lubricate the threads and abutment faces,
R refit the nuts and retighten to the specified torque load.

R 4. Preliminary smoothing of threads and mating faces

R A. Smooth the threads

R NOTE: Smoothing the threads is only necessary when threaded
R parts are being fitted with loads in excess of
R 250 lb.ft. being applied.

(1) Lubricate the threads and mating faces of the nut and washer with clean engine oil (OMat Item 1011) or PL.198 (OMat Item 4/20) unless otherwise instructed.

(2) Tighten the nut until approximately half the torque load value is obtained

(3) Remove the nut re-lubricate threads and mating faces, then re-tighten until the full torque load value is reached.

B. Smooth the mating faces

Shrouded tab washers are prone to 'dishing' during manufacture and do not always flatten satisfactorily with a single torque tightening application; therefore, where shrouded tab washers are used, effect a double tightening procedure, as follows:

(1) Lubricate the screw threads and mating faces with clean engine oil, or PL.198, unless otherwise instructed.

(2) Tighten the nut to the full torque load.

R (3) Undo nut one turn then re-tighten until the full torque load value is obtained.

5. Torque tightening involving locking device

A. Where locking plates, tabwashers or split pins (cotter pins) are used as locking devices the following instructions must be complied with:

CAUTION: 1. FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN FAILURE OF THE UNIT OR ENGINE.

2. DO NOT SLACKEN THE NUT TO OBTAIN THE LOCKING POSITION.

(1) If a single torque load value is specified, it is permissible, and in many instances necessary, to exceed the prescribed torque load value by continuing to tighten the nut until the next locking position is reached.

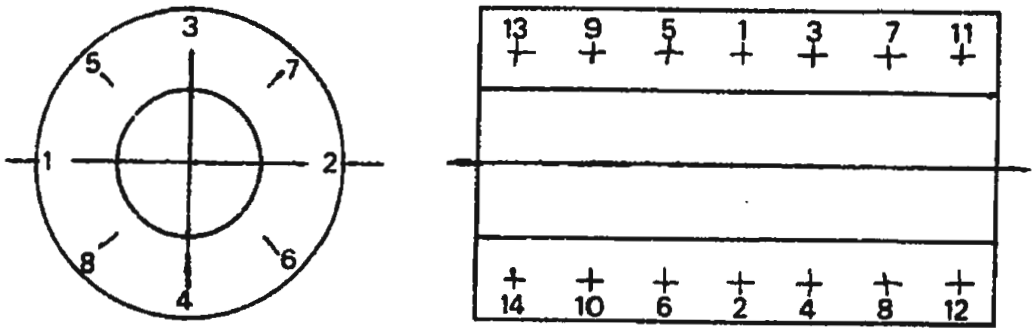
(2) If a minimum and a maximum torque load value is quoted, the final torque load value applied must be within the prescribed range.

6. Torque Tightening Sequence

A. Where close pitch bolting is used and where it is necessary to make a seal, adjacent fastners should not be tightened successively; tighten in a symmetrical pattern to ensure that strain is not induced into the structure. Unless specified otherwise in the manual, the following procedure is recommended.

(1) On flanges, lightly nip two fasteners approximately opposite to each other and then lightly nip up another pair approximately at 90 degrees to the first pair; bisect the resulting angles and proceed as before; refer to Fig.1. When the faces are in light contact with all fastners lightly nipped, apply the specified tightening torque in a similar sequence.

(2) On half-casing split lines, e.g. compressor casings, use the same method but tighten the mid-section positions first and then work outwards from the centre, refer to Fig.1.



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R Examples of bolt tightening sequences used on
R ring flange and half-casing joints
R Fig.1

B. On face-tooth joints, usually in a Curvic or Hirth coupling in an engine main shaft system, the correct torque tightening technique is important to maintain rotor balance and concentricity and is dealt with in para.18.

7. Hand torque wrenches

A. Flexible beam type

(1) To obtain a correct reading, the handle should be gripped lightly with one hand. As the pull must be applied at right-angles (90 degrees) to the centre line of the wrench, the handle should float on the pivot-point thus concentrating the force or load at
R the correct point, refer to Fig.2. The position of
R the hand should not be altered so as to change the
R concentration of the force from the pivot-point to any other position on the handle. The following table lists flexible beam type torque wrenches and their torque load ranges:

	Range		Size of Drive	
Part No.	N.M.	lbf. in.	mm.	in.
1703079	0 to 5,650	0 to 50	5,56	17/32
1703151	3,390 to 15,8	30 to 140	6,35	1/4
1703081	17,0 to 67,8	150 to 600	9,52	3/8
3403424	0 to 203	0 to 1800	12,70	1/2

(2) All wrenches must be checked periodically on the setting rig, to ensure that they are reading accurately. Interchangeable sockets, adapters and extension bars are provided for use with all wrenches.

(3) To ensure the greatest possible accuracy in reading the scale values, choose a torque wrench which, in use, will register within the higher range of the scale. The first and final quarter of the scale should not be used for mandatory loads, because the accuracy with which small loads can be read at the beginning or end of the scale is not considered adequate. Wherever possible, a wrench should be selected where full benefit would be obtained from the scale provided. Some flexible beam torque wrenches may have the 'unacceptable' part of the scale blank. Before use
R set the wrench to zero load.

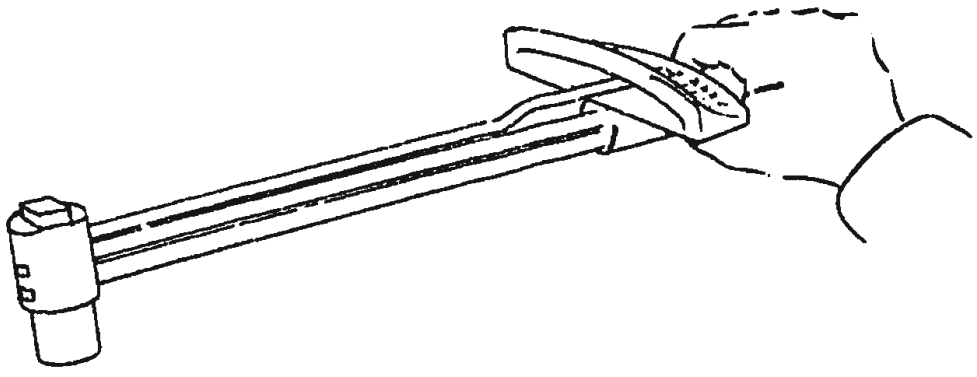

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Fig. 1

R Correct method of holding a flexible beam torque wrench
R Fig.2

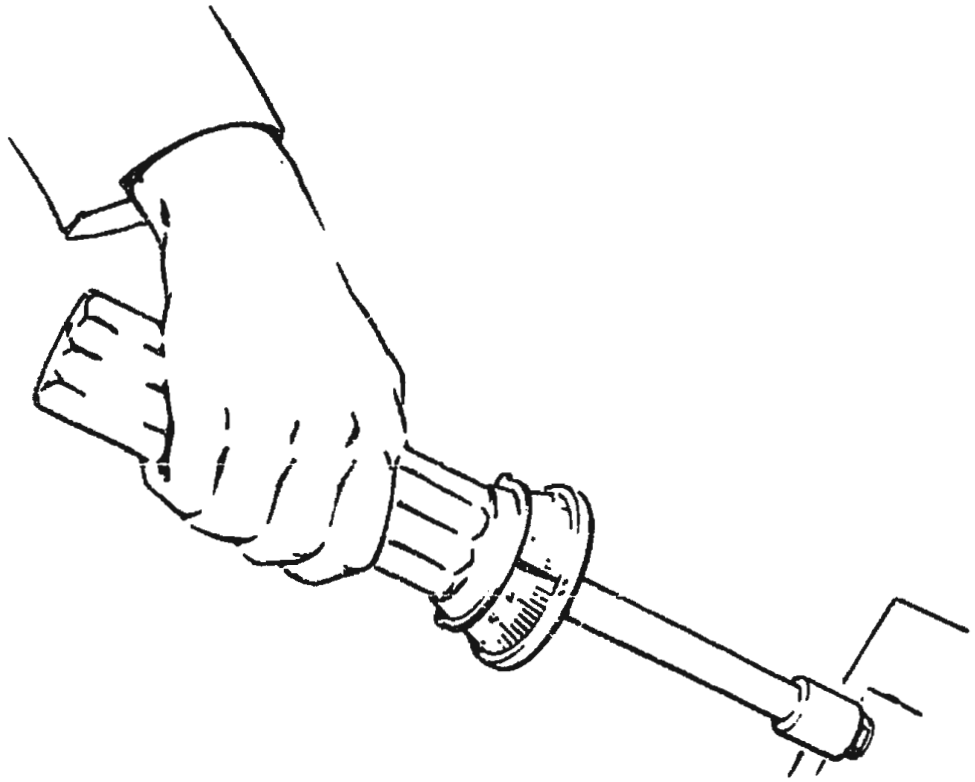

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Fig. 3

R Correct method of holding a screwdriver torque wrench
R Fig.3

R B. Screwdriver type

R (1) To obtain a correct reading, the handle must be gripped R as if holding a screwdriver and rotated smoothly R until the required load figure is indicated. (Refer to R Fig.3). The following table lists the screwdriver type R torque wrench and the torque loading range.

R	Range		Size of Drive	
R Part No.	N.M.	lbf. in.	mm.	in.
R 1703038	0,9 to 2,7	8 to 24	6,35	1/4

R (2) Screwdriver type wrenches in service must be inspected R for accuracy.

R Under conditions of no load, check that the torque R indicating pointer reads zero on the scale; if R necessary adjust as instructed in the torque wrench R manufacturer's instruction book.

R 8. Power wrenches

R A. Power wrenching must only be used for preliminary tightening R of nuts and bolts. The power wrench must be set to give R 50 per cent of the final torque load, and the final torque R applied using the approved hand torque wrench.

R 9. Torque Multiplier

R A. The torque multiplier is a mechanical gearbox or hydraulic R unit used in conjunction with the torque wrench, in order R to achieve higher torque loads than those possible with the R normal range of torque wrenches. It is essential therefore, R that the torque wrench scale reading is co-related to the ratio of the unit being used. The torque multiplier should R be calibrated at regular intervals and maintained in R accordance with the manufacturers instructions.

R CAUTION: WHEN MEASURING TORQUE DO NOT USE UNIVERSAL JOINTS, R THESE MAY PRODUCE SERIOUS INACCURACIES.

R 10. Extension spanners

R A. Extension spanners can be used in either of two angular
R positions relative to the torque spanner. Whenever
R extension spanners are used the following rules and
R formula must be used.

R B. It is essential that, unless inaccessibility dictates
R otherwise, the extension spanner should always be in-line
R with the torque spanner and the torque spanner scale
R readings adjusted accordingly.

R C. Where the extension has to be fitted at the alternative
R position because of limited access, the shortest possible
R extension shall be used and care taken to apply the load
R at the wrench handle at RIGHT-ANGLES to the length of the
R wrench, to avoid errors.

R D. It is also essential to note that with the extension spanner
R in the alternative 90 degrees angular position, the torque
R reading correction factor does not normally apply if the
R extension spanner is of the correct design. Referring to
R Fig.4 dimensions A and C are identical.

R $$\text{Scale reading} = \frac{\text{Required Torque x Length of Lever (A)}}{\text{Total Lever Length (B)}}$$

R NOTE: 1. All lengths are measured using the pivot in the
R handle as the datum.

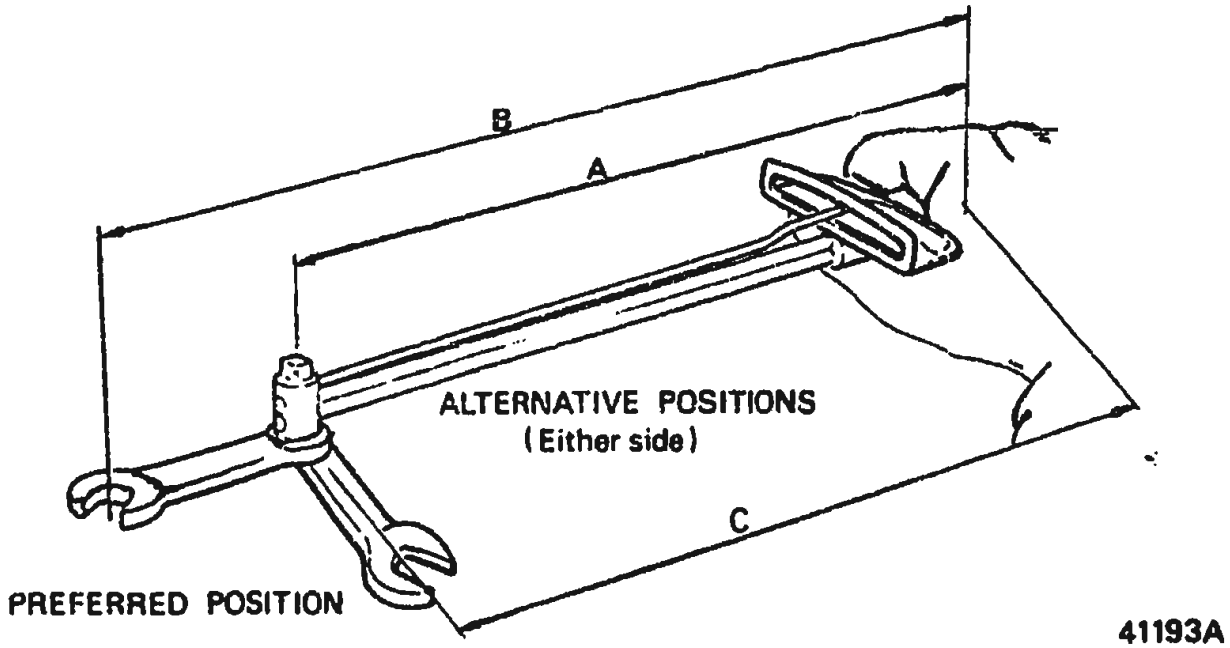
R 2. Length B should be measured parallel to the
R torque wrench lever as shown in Fig.4.

R Example:
R A nut with 0.250in. thread dia. is to be tightened
R to 10 N.m. using a torque wrench 250 mm. long and
R with an extension of 76 mm., fitted in the
R preferred position, giving a total lever strength
R of 326 mm.

R The indicated scale reading must be:

R $$\frac{10 \times 250}{326} = 7{,}6 \text{ N.m.}$$

R NOTE: The lengths A and B may be in any units,
R Imperial or Metric, provided they are both
R in the same units.



Torque wrench and extension
Fig.4

R 11. In-built (locking) torque for self-locking fasteners

R A. The in-built torque is the torque required to start the nut or setscrew turning when:

R (1) The nut is engaged on the stud or bolt (or the setscrew is engaged in the insert or captive nut) with the full chamfer of the stud or bolt (or setscrew) extending beyond the locking device of the nut, insert or captive nut.

R (2) There is no axial load on the nut or bolt.

R B. Do not alter the in-built torque of a nut or insert by 'crimping' the lock device or by 'easing' it with a thread tap.

R IN-BUILT LOCKING TORQUE

Nominal thread size -in.	Minimum N.m.	Minimum lbf.in.	Maximum N.m.	Maximum lbf.in.
4 UN	0.056	0.50	0.338	3.0
6 UN	0.113	1.00	0.676	6.0
8 UN	0.169	1.50	1.017	9.0
10 UN	0.225	2.00	2.030	18.0
0.250in.	0.394	3.50	3.390	30.0
0.3125in.	0.733	6.50	6.780	60.0
0.375in.	1.070	9.50	9.040	80.0
0.4375in.	1.580	14.00	11.300	100.0
0.500in.	2.030	18.00	17.00	150.0
0.5625in.	2.710	24.00	22.600	200.0
0.625in.	3.620	32.00	33.900	300.0
0.750in.	5.650	50.00	45.200	400.0
0.875in.	7.910	70.00	67.800	600.0
			N.m.	lbf.ft.
1.000in.	10.4	92.00	90.30	66.60
1.125in.	13.2	117.00	102.00	75.00
1.250in.	16.2	143.00	113.00	83.30

R Range of in-built torque limits for self-locking nuts, wire-thread inserts and captive nuts
R Fig.5

R C. There are various methods of checking locking torque but
R the ultimate criterion is that the correct locking torque
R must be present when the bolt, nut or setscrew is finally
R fitted, and in principle all such self-locking fastners
R should be checked at that stage. In pratice it is not
R always necessary to measure locking torque during final
R fitting, and some relaxation is possible depending upon
R the particular application. The following procedures
R take this into account:-

R (1) No.10 UN and 0.250in. fasteners used in application
R for which no special instructions are given in the
R manual, may be checked for correct locking torque
R by hand during final fitting. If the locking device
R cannot be fully engaged when tightened as much as
R possible with the fingers, then the fastener is
R acceptable.

R (2) All other applications of No.10 UN and 0.250in.
R fasteners involve joints where high integrity is
R essential and are covered by special instructions in
R the manual. In all these instances, the locking
R torque must be measured during final fitting.

R (3) On all fasteners sizes above 0.250in., whether the
R torque load is standard or non-standard, the actual
R locking torque must be measured during final fitting.

R D. To ensure the correct locking torque during final fitting, fasteners may be checked before this stage using the gauges listed in Fig.6. By this means, the need to remove and replace fasteners during final fitting can be avoided.

R CAUTION: CONTAMINATION OF SILVER-PLATED NUTS OR INSERTS BY CADMIUM OR MOLYBDENUM DISULPHIDE CAN RESULT IN SERIOUS FAILURE DURING SUBSEQUENT SERVICE. GAUGES USED ON SILVER-PLATED FASTENERS MUST NOT BE USED FOR CHECKING ANY OTHER PARTS.

THREAD BASIC SIZE	GAUGE NO.
0.190 - 32	HU24461
0.250 - 28	HU24462
0.3125 - 24	HU24463
0.375 - 24	HU24464
0.4375 - 20	HU24465
0.500 - 20	HU24466
0.5625 - 18	HU24467
0.625 - 18	HU24468

R Torque check gauges
R Fig.6

R 12. Fitting non self-locking nuts to studs or bolts; also fitting
R bolts, used as setscrews, in non self-locking thread holes

R A. Apply the standard torque loads listed below unless
R special torque loads are specified elsewhere:

R TIGHTENING TORQUE - NON SELF-LOCKING

R Nominal thread size in.	Unplated and Silver plated		Cadmium plated	
R	N.m.	lbf.in.	N.m.	lbf.in.
R No.6 UNF	1,10	10	0,90	8
R No.8 UNF AND 2 B.A.	1,70	15	1,10	10
R No.10 UNF	4,00	35	2,80	25
R 1 B.A.	5,70	50	4,00	35
R 0.250in.	11,30	100	8,50	75
R 0.3125in.	19,20	170	15,30	135
R 0.375in.	33,90	300	26,60	235
R 0.4375in.	50,90	450	40,70	360
R 0.500in.	84,80	750	65,00	575
R 0.5625in.	107,40	950	83,60	740
R 0.625in.	152,60	1350	118,7	1050

R Standard torque loads for fitting non self-locking nuts and bolts
R Fig.7

R 13. Fitting self-locking nuts to studs and bolts; also bolts used as
R setscrews, in self-locking wire-thread inserts or in self-locking
R thread captive nuts

R A. Apply the standard torque loads listed below unless special
R torque loads are listed elsewhere.

R B. Self-locking nuts and inserts have a limited life which
R depends, mainly, on their ability to retain their in-built
R locking torque. For values of acceptable range of in-built
R torque, refer to Fig.5.

R TIGHTENING TORQUE - SELF-LOCKING

R Nominal thread size in.	Unplated and Silver plated		Cadmium plated	
R	N.m.	lbf.in.	N.m.	lbf.in.
R No.6 UNF	1,40	12	1,10	10
R No.8 UNF AND 2.B.A.	2,30	20	1,70	15
R No.10 UNF	4,50	40	3,40	30
R 0.250in.	11,30	100	10,20	90
R 0.3125in.	23,70	210	19,20	170
R 0.375in.	41,80	370	35,00	310
R 0.4375in.	55,40	490	46,30	410
R 0.500in.	89,3	790	72,30	640
R 0.5625in.	114,10	1010	93,80	830
R 0.625in.	163,90	1450	135,60	1200

R Standard torque loads for self-locking nuts, setscrews in wire-thread
R inserts and captive nuts
R Fig.8

14. Tube connections (union nuts, tube and hose connections)

R CAUTION: PREVENT DAMAGE TO PIPES AND UNIONS BY USING A SUITABLE
R SPANNER TO PREVENT ROTATION OF THE UNION WHEN ASSEMBLING
R OR DISASSEMBLING A PIPE CONNECTION.

R A. Apply the torque load values listed in Fig.9 to all standard
R tube/pipe connections unless otherwise instructed.

R B. Bed-in nut and nipple connections as follows:

R (1) Using clean engine oil as a lubricant on the threads
R and abutment faces assemble nut and nipple to the
R union and tighten to the recommended torque load value.

R (2) Loose the connection by slackening the nut half a turn.

R (3) Tighten and loosen twice more.

R (4) Finally tighten to recommended torque load value.

R CAUTION: DO NOT EXCEED THE SPECIFIED TORQUE LOAD VALUE
R WHEN TRYING TO ACHIEVE A SATISFACTORY SEAL.

C. Rectify a leaking connection by disassembling the nut and nipple connection examining parts for cause of failure to seal, and, if necessary, fitting new parts. Reassemble as detailed in B.(1) to (4).

TIGHTENING TORQUE - TUBE CONNECTIONS

Nominal thread size -in.	Nm.	lbf.in.	lbf.ft
0.4375-20	16,50	145	-
0.5000-20	19,00	170	-
0.6250-18	24,00	215	-
0.6875-16	27,00	240	-
0.7500-16	30,00	265	-
0.8125-16	33,00	295	-
0.8750-14	37,00	325	-
1,0625-12	47,00	420	-
1,1875-12	56,00	500	-
1,3125-12	67,00	590	-
1,6250-12	99,00	-	73
1,8750-12	135,00	-	99

Standard torque loads for tube connections
Fig.9

15. Screwed unions and hexagon-headed blanking plugs

A. The torque tightening values for both unions and hexagon-headed blanking plugs are identical for given thread diameters and are given in the table below, Fig.10. The values are based on the practice of tightening the union to a torque approximately 20 per cent higher than for the union nut; this reduces the tendency for the union to turn when the tube nut is tightened or loosened.

B. When fitting unions or plugs, clean engine oil should be used to lubricate the threads, except when the fitting is to be screwed into magnesium alloys. If they are to be fitted to magnesium alloys the threads and abutment face of the union or plug should be smeared with Jointing Compound, Sq32L or PL.32L which must be allowed to air dry for approximately 10 minutes before assembly.

C. After ensuring that the items are clean, and fitting any necessary joint washers, they should be assembled to the torque values specified in the table below, Fig.10.

UNIONS AND HEXAGON-HEADED BLANKING PLUGS

Nominal thread size -in.	Tightening Torque Nm.	lbf.in	lbf.ft
0.250-28	5	44	-
0.3125-24	9	80	-
0.3750-24	12	110	-
0.4375-20	20	175	-
0.500-20	23	205	-
0.5625-18	26	230	-
0.6250-18	29	260	-
0.750-16	36	320	-
0.8125-16	40	355	-
0.875-14	44	390	-
1.0625-12	57	505	-
1.1875-12	68	-	50
1.3125-12	80	-	59
1.6250-12	120	-	87.5
1.8750-12	160	-	119

Torque tightening values for unions and hexagon-headed blanking plugs
Fig.10

R 16. Fitting serrated-head sealing plugs

R A. Apply the torque loads listed in Fig.11 to sealing plugs
R fitted into either aluminium or magnesium unless special
R values are specified elsewhere.

R B. When fitting sealing plugs, clean engine oil should be
R used to lubricate the threads, except when the plug is to
R be screwed into magnesium alloys. If they are to be
R fitted to magnesium alloys the threads and abutment face
R of the plug should be smeared with Jointing Compound,
R Sq.32L or PL.32L which must be allowed to air dry for
R approximately 10 minutes before assembly.

R C. Do not overtighten sealing plugs beyond the recommended
R torque load value to cure a leak. If necessary, fit a
R new sealing plug and/or recondition the plug seating.

R TIGHTENING TORQUE - SERRATED-HEAD SEALING PLUGS

Nominal diameter -in.	N.m.	lbf.in.
0.250	2,26	20.0
0.3125	3,39	30.0
0.375	5,08	45.0
0.4375	7,34	65.0
0.500	10,2	90.0
0.5625	10,2	90.0
0.625	15,8	140.0
0.6875	20,3	180.0
0.750	20,3	180.0

R Standard torque loads for fitting serrated-head sealing plugs
R (Unified or Whitworth threads)
R Fig.11

R 17. Fitting studs

R Studs are usually fitted as replacements, when fitting
R replacement studs refer to the Standard Practice Replacement
R of Studs.

R 18. Assembly of Face Tooth Joints

A. General

R To standardize the assembly of face tooth joints in order to achieve the high degree of balance consistent with the design aspects of these type of coupling, the following procedure is to be applied in all circumstances where two parts of a face tooth joint are brought together e.g. engine build, mating modules, balancing (with engine and slave components).

This procedure is applicable to Curvic couplings, Hirth couplings and any other form of face tooth joint.

The tightening torque values are applicable to both self-locking and non self-locking fasteners.

B. Assembly procedure

(1) Immediately before bringing together the two parts of
R the face tooth joint, clean the teeth to remove all
R foreigh particles, grease, oil, etc., and ensure they
R are free from burrs; this is very important as quite small particles can upset the seating of the teeth.

R (2) When builing the engine horizontal, the two parts are to be brought together with sufficient accuracy to
R ensure even mating of the teeth and avoid shear loading.

R (3) Lubricate, with engine oil (Omat, Item 1011) or PL198
R (OMat, Item 4/20), fastener threads and the bearing
R surface of the nut or bolt, whichever is to be wrenched,
R engage, the threads, but do not run down.

R NOTE: Ensure that the lubricant does not encroach on
R to the coupling teeth.

(4) Tightening sequence

R (a) Each bolt hole is identified by a number, indicating the sequence for tightening the nut/bolt combination or, in the case of small size couplings with 10 or less bolts, the tightening sequence will be specified in the relevant section of the appropriate Manual.

(b) If the joint is being assembled with its axis horizontal, position holes 1 and 2 on the horizontal axis. If there are an odd number of bolts, hole number 1 is to be on the horizontal axis.

(c) Starting with the nut/bolt combination in hole 1 and continuing in numerical sequence, tighten to the initial torque value specified in fig.12.

Thread dia.(in.) and T.P.I.	Initial torque lbf.in.	Initial torque N.m.
No.10-32	20	2,20
0.250-28	40	4,50
0.3125-24	80	9,00
0.375-24	110	12,00
0.4375-20	130	15,00
0.500-20	200	23,00
0.5625-18	260	29,00

Initial torque values
Fig.12

(d) Following the same sequence, tighten each nut/bolt combination to the intermediate torque values specified in fig.12.

Thread dia.(in.) and T.P.I.	Intermediate torque lbf.in.	N.m.
No.10-32	25	2,8
0.250-28	50	5,60
0.3125-24	100	11,00
0.375-24	180	20,00
0.4375-20	250	28,00
0.500-20	400	45,00
0.5625-18	500	56,00

Intermediate torque values
Fig.13

R (e) Following the same sequence, tighten each nut/bolt combination to the final torque values specified in fig.14 or the special loading specified in Fits and Clearances or the appropriate manual section.

Thread dia.(in.) and T.P.I.	Final torque lbf.in.	N.m.
No.10-32	40	4,50
0.250-28	100	11,00
0.3125-24	210	24,00
0.375-24	370	42,00
0.4375-20	490	55,00
0.500-20	790	90,00
0.5625-18	1010	115,00

Final tightening torque values
Fig.14

(f) Finally, starting with the nut/bolt combination in hole 1 and proceeding in a clockwise direction, check each nut/bolt combination in turn to the torque value specified in fig.14 or the special loading specified in Fits and Clearances or the appropriate manual section.

STORAGE OF RUBBER RINGS, FLEXIBLE HOSES AND OTHER RUBBER COMPONENTS

1. Shelf Life

A. The reference point from which the shelf life of rubber and synthetic rubber parts is calculated is the cure date. It is marked on the parts and/or on their associated packaging and applies to all 'uninstalled' rubber or synthetic rubber parts, bonded rubber to metal parts, cables, harnesses, hoses and hose assemblies but not to assembled units and accessories, e.g. fuel units.

B. The cure date is shown as the quarter of the year (expressed as a single figure) and the year (expressed as a double figure) of manufacture, separated by the letter Q; e.g. 2Q71 is the cure date for a part manufactured in the second quarter of 1971. The year is divided into quarters as follows:

(1) January, February, March. (2) April, May, June.
(3) July, August, September. (4) October, November, December.

NOTE: On some parts, the month of manufacture may be shown in brackets after the cure date, e.g. 2Q71 (May).

C. The age of any part is calculated from the end of the quarter in which the part was manufactured. Thus a part with the cure date 2Q71 would be one year old at the end of the second quarter of 1972, i.e. 30th June, 1972.

2. Cure Date Marking

A. The method of showing the cure date of 'uninstalled' or 'separate' rubber or synthetic rubber parts is as follows:

(1) Individual parts (except sealing rings) large enough to be marked, e.g. diaphragms and bulkhead seals, are stamped or stencilled with a permanent marking fluid of a contrasting colour.

(2) Individual parts which cannot be marked owing to size, and sealing rings, are packed in marked envelopes supplemented by labels attached to the part or batch.

(3) All basic envelopes, bags or packages and all intermediate and/or exterior containers in which the items are packaged, are marked with the cure date. In addition each envelope, bag or package shows the manufacturer's name or reference, Rolls-Royce part number and batch number.

(4) Hoses are marked with 2 separate groups of figures and letters which are repeated along the full length of hose. The first group gives manufacturing data such as 'mix' information, whilst the second group gives length or batch number and cure date as follows:

First 4 figures	-	length or batch number	
Next or middle figure and letter	-	quarter symbol and 'Q'	cure date
Final 2 figures	-	year symbol	

Example: 01012Q68 - 101st length or batch produced in the second quarter of 1968

(5) Hose assemblies are, in addition to the coding on the hose element, marked by the following identification tabs:

(a) Coding tab (repeat of hose coding)

(b) Identification tab (showing hose piece number, test date, inspector's stamp and maker's identification).

(c) Cure date tab (showing cure date of hose).

(6) All basic packaging and all intermediate and/or external containers for hoses and hose assemblies are marked with the cure date.

3. Storage of Parts

A. Maintain rubber and synthetic rubber parts in good condition and ensure maximum shelf life by careful attention to storage conditions. Store parts under conditions which provide the maximum possible protection against the effects of strain, direct sunlight, ozone, moisture, excessive circulation of air, extremes of temperature, physical damage and contamination by fuels, oils, greases, or solvents. If the parts are supplied packed in envelopes, plastic bags or cartons, they should be kept in this condition until required for service. Avoid excessive shelf storage time by relating level of stocks to rate of use and by issuing parts on an 'age' basis, that is, oldest items, as shown by cure date, first. Do not allow direct contact between rubber parts and metals (especially containers made from copper).

B. Store parts in a relaxed position free from tension and, wherever possible, in their normal shape. Avoid excessive vertical stacking of parts as this can cause permanent distortion of the lower layers. Store flexible hoses in straight lengths, wherever possible, as 'coiling' produces tension in the outside of each coil and increases the risk of ozone cracking.

C. Provide sufficient ventilation to prevent condensation but prevent currents of air from coming into contact with the stored parts. Avoid, as much as possible, sources of ozone such as mercury vapour lamps, electrical machinery and an excess of outdoor air which, in temperate climates, always contains ozone. Ensure that parts are shielded from direct sunlight.

D. Store lip type seals in such a manner that damage and distortion to the sealing edge is avoided, and do not tie labels directly to the seals. Do not fit sealing rings to ferrules or bobbins until immediately before installation into an engine or unit as stretching and exposure to light can cause deterioration.

E. Maintain storage temperature within the preferred range of 15 to 21 degrees C. (59 to 70 degrees F.) with a minimum of 5 degrees C. (41 degrees F.) and a maximum of 38 degrees C. (100 degrees F.), and an air relative humidity of 65 per cent. Store parts at least 3 feet from any unscreened source of heat.

F. If stored under the preceding recommended conditions the shelf life of rubber parts is virtually unlimited, subject at specified intervals in certain cases to a monitoring inspection. For this purpose, rubber types have been divided into 3 groups.

Group A

	Material spec.
Natural rubber)	MS 717

These can be supplied to a customer up to 5 years from cure date. The subsequent shelf life is unlimited, subject to satisfactory inspection (see para.4.) of a sample of the oldest stock at least every 2 years.

Group B

	Material spec.
Butyl	MS 754, 757
Neoprene (Chloroprene)	MS 710, 716 (BS2752 Grade C3 or C4)

These can be supplied to a customer up to 7 years from cure date. The subsequent shelf life is unlimited, subject to satisfactory inspection (see para.4.) of a sample of the oldest stock at least every 3 years.

Nitrile	MS727, 735, 743, 744, 747, 765 MSRR 9454, 9455 BSEM 602 DTD 5509, 5595, 5607

R R These may be supplied to a customer up to 10 years from cure date. The ultimate life is 15 years.

Group X

		Material spec.
Silicone	)	MS732, 741, 751, 756, 761, 771
Fluorosilicone	)	MSRR 9450 (MS762), 9451 (MS782),
Fluorocarbon (Viton)	)	9452 (MS766), 9453, 9490
		BSEM 608, 534
		DTD 900/4882A, 5543, 5603, 5612, 5613

There is no life limit for supply to a customer or for storage. Cure date marking has only been retained to assist stock monitoring.

R NOTE: 1. Rubber parts in Groups 1 and 2 (except Nitrile) supplied to a customer for immediate use on engines and therefore not intended to be stored, may have exceeded the cure date limit. This is acceptable since the vendors storage conditions are close to ideal.

2. Material spec. numbers are only marked on packaged components.

4. Inspection of parts

A. Examine parts for signs of 'ageing' or degradation due to oxidation. This is shown by surface cracks and deterioration. To check, flex the part gently and discard if cracks are present before or after flexing.

B. Do not automatically discard parts due to the presence of a white or coloured 'bloom' on their surface. Such blooms are often desirable anti-ageing layers and originate from the anti-oxidants used in high grade rubber.

C. Examine all parts for the following; discard if faulty:

(1) Permanent distortion, flats and other obvious defects.

(2) Tackiness or surface hardening or softening.

(3) Blistering, peeling or cracks when rubber is extended or flexed.

(4) Chafing of outer coverings and corrosion of, or damage to, end fittings of hose assemblies and cable harnesses.

(5) Corrosion of metal elements in bonded rubber to metal assemblies.

(6) Obstruction of the bore (flexible hoses).

D. Pressure test flexible hoses as instructed in the relevant sections of this manual. If it is essential to fit a flexible hose when no facilities for pressure testing exist, then the hose must be removed for testing at the first available opportunity. On completion of pressure testing, drain the hose, blow through with clean air and seal the ends with blanks.

E. Test electrical cables and harnesses for resistance where applicable, insulation resistance and continuity as well as for chafing of the loom and satisfactory condition of the end fittings, as instructed in the relevant sections of this manual.